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# POWER

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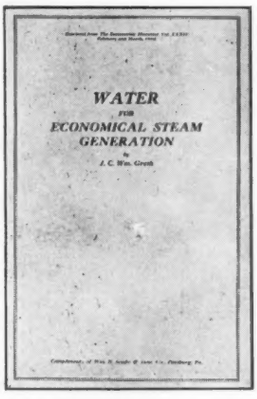
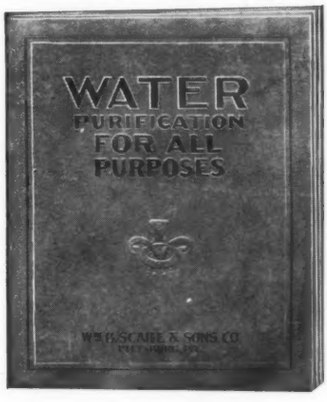
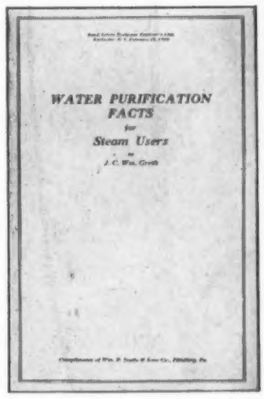
Price, 5 cents.
Outline of Topics, 58.
Index to Advertisers, 48.


# All About Water Purification

## Write For These Free Books
## They Make Clear A Foggy Subject




¶ Water Purification is a big subject. When properly handled it guarantees big results. Hundreds of plants who think they do not need a water softening system are, as a matter of fact, operating at a loss. Hundreds of power plant men who think that the cost of a water softening system is prohibitive, would quickly change their minds if they knew the true economy facts. Hundreds of power plant men have but a slight knowledge of the principles of water softening, and the results possible through the installation of such a system. It is the purpose of this company to tell you about these things. We'll answer it correctly, backed by an experience gained by installing hundreds of water softening systems which are now treating more than 300,000,000 gallons of water daily. The above books have an educational value, and if you read them you cannot help having a clear knowledge of a subject regarding which the majority of power plant men are in the dark.

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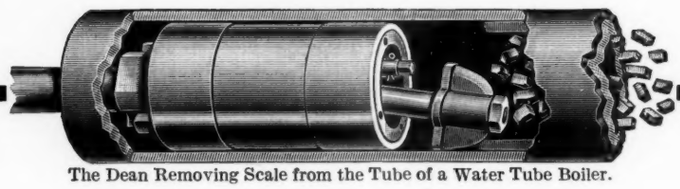

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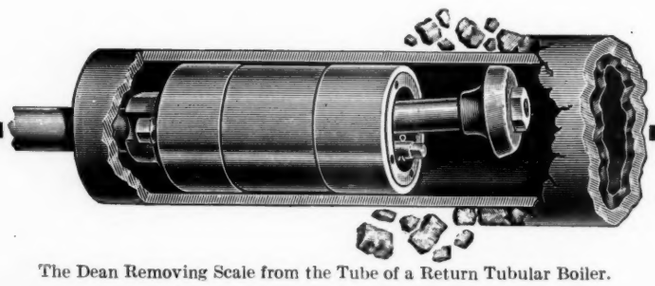

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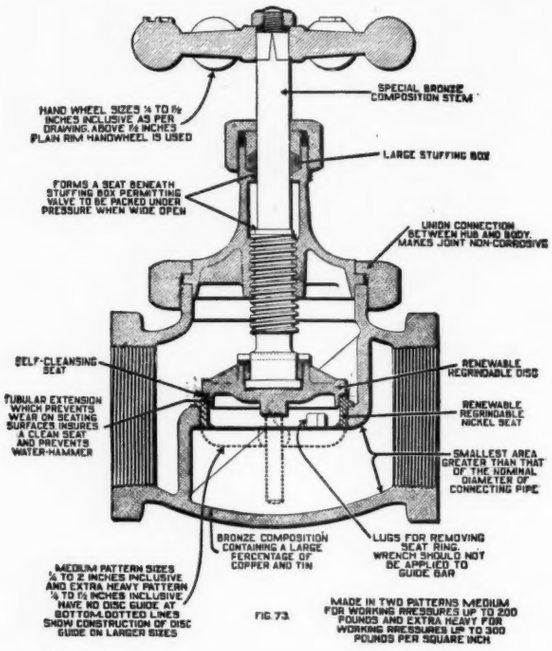
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LUGS FOR REMOVING SEAT RING. WRENCH SHOULD NOT BE APPLIED TO GUIDE BAR
MEDIUM PATTERN SIZES ¼ TO 2 INCHES INCLUSIVE AND EXTRA HEAVY PATTERN ¼ TO 1½ INCHES INCLUSIVE HAVE NO DISC GUIDE AT BOTTOM. DOTTED LINES SHOW CONSTRUCTION OF DISC GUIDE ON LARGER SIZES
FIG. 73.
MADE IN TWO PATTERNS MEDIUM FOR WORKING PRESSURES UP TO 200 POUNDS AND EXTRA HEAVY FOR WORKING PRESSURES UP TO 300 POUNDS PER SQUARE INCH

A valve that has sufficient strength; made of materials best suited for steam use; faultless workmanship; large areas, insuring a free and unobstructed passage of steam, and so designed that all parts can easily be renewed,—must be conceded as one that is perfect, or as nearly so as can be attained.

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can justly be called a valve of perfection, as it embraces all of the above necessary features, and more too, as the seating faces can be reground many times, without removing the valve from its connecting pipe, before it is necessary to renew the seat or disc.

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Other features that aid in maintaining the high reputation of the valve, are,—a non-corrosive union connection between the hub and body, permitting the valve to be easily taken apart or assembled; a ***renewable seat*** made of a ***hard*** and ***close-grained nickel,*** having great durability,—and a stuffing-box that can be packed under pressure when the valve is wide open.

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1

# SMILE

A smile somehow or other signifies that a man has done his best and is pleased with the results.

There's nothing of fear in it, or lack of confidence, or worry.

An employer talking to his engineer would naturally prefer talking to a man who meets him with a confident smile than to one who has a frown or a worried look on his face.

But when an engineer knows that the coal bill is getting higher and higher—that boiler steaming capacity is getting lower—that he's got a badly scaled boiler to clean out on Sunday—why—how can he keep a smile on his face?

Well, there's no reason why you should continue to put up with scale worries—they are more or less of a habit anyhow—

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Then *you* can meet your employer with a smile whenever he comes into your department or you go to his office—then you'll be able to spend a little more of your own time in your own way.

Send us a gallon of your feed water and let us send you some facts that apply particularly to your boiler problem. Send this today.

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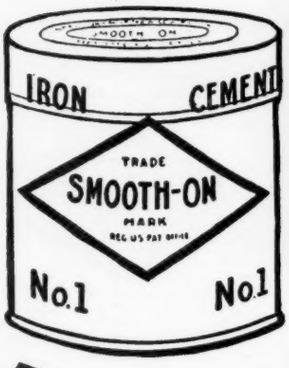


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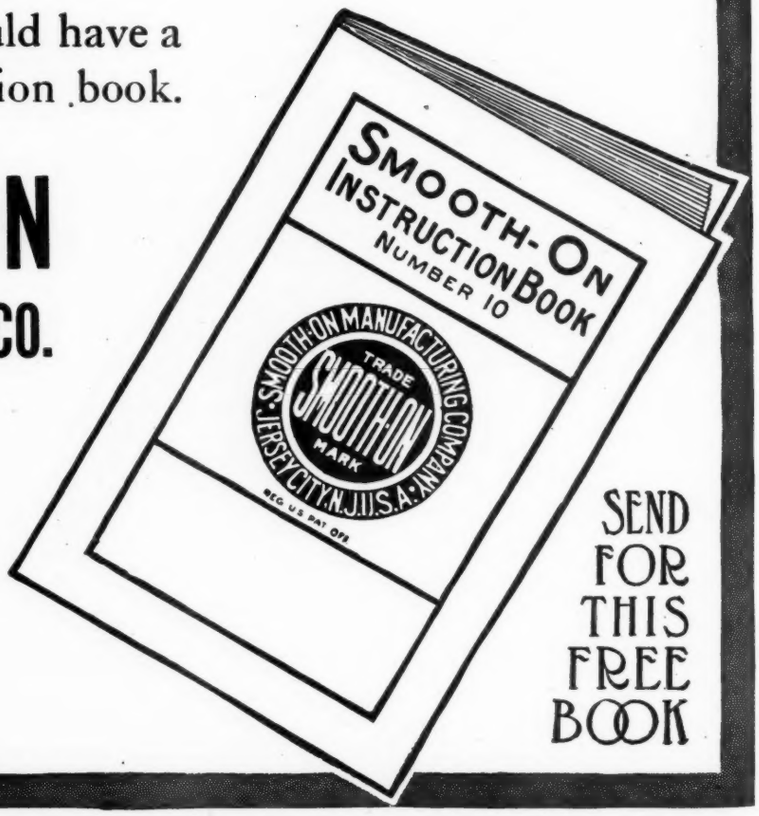


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# POWER

Vol. 35 NEW YORK, APRIL 30, 1912 No. 18

THE person who, without permission, will walk by the "No Admittance" sign at the entrance to an engine-room is on a par with the fellow who reads the "Fresh Paint" warning and then deliberately jabs his thumb into it to prove it. Signs mean little to him.

Not long ago, during the temporary absence of the engineer, a representative of an electrical company, who had been sent to make minor repairs, walked past the "No Admittance" sign at the door, and proceeded, without permission, to work on the three-wire-generator which was in operation.

In some unknown manner, he dropped a metal case between the commutator and collector rings. Instantly the machine emitted a volume of sparks. Bewildered, the trouble-maker started to open the individual circuits, instead of throwing the main circuit-breaker and also reducing the voltage until the engine could be stopped.

The engineer soon arrived, and after shutting down, he demanded to know what the intruder meant by ignoring the sign at the door.

"If you had obeyed that sign, you would have waited until I returned, and all the trouble your carelessness has caused me could have been prevented."

The following case illustrates where another engineer insisted on the observance of the "No Admittance" rule: While Old Herman, who always worked the 12 midnight to 8 a.m. watch, was absorbed in reading his report, he suddenly looked up and saw a well groomed intruder closely scrutinizing the switchboard.

Herman shouted at him: "Hey, you, git oudt of here! Didn't you see dot sign at der door?"

"Yes," smilingly answered the gentleman.

"Vell, for why you didn't pay no attention by it? For why you didn't ring der bell?"

"Apparently you do not know who I am. I'm Mr. Blank, the general manager."

"How do I know you are? I'm here to enforce der rules, undt I'm going to do it. Git oudt anyway!" retorted Herman, as he ushered the visitor out and slammed the door.

"Vell," muttered Herman, as he resumed his reading, "if he's Mr. Blank I may be fired in der morning; but rules is rules."

Contrary to Herman's fears, the manager was pleased to know that he had a man who fearlessly obeyed orders and executed them to the letter.

If you have been hitherto negligent in enforcing this rule in your plant, now is the time to polish the old sign and also install a call bell, and see that it is used by outsiders seeking admittance to the plant. Those having business with the engineer are no more privileged to walk by the "No Admittance" sign than they are to crowd by the boy in the president's office when seeking an interview.

# Small Chinese Power Plant

By Walter H. Adams*

**An uptodate plant, the equipment of which was collected in four different countries, supplying light, heat and power to the buildings of the Imperial Pei-Yang University. A water purification plant and pumping station is also installed.**

*Professor of mechanical engineering, Imperial Pei-Yang University, Tientsin, China.

The Imperial Pei-Yang University is situated on the bank of the Pei Ro (North River) about five miles north of the foreign settlements of Tientsin and two miles from the native city. On three sides it is surrounded by open fields and on the fourth by the river.

The companies operating the lighting and water systems of Tientsin would not extend their service to the university owing to the distance and the small remuneration that could be expected; hence the university authorities decided to install a plant of their own for supplying light, heat, power and water. This was completed in 1910 and is interesting chiefly because of its component parts and its location, rather than its size.

FIG. 1. GENERAL VIEW OF PLANT

The apparatus was collected from the United States, England, Germany and China, and was installed by Chinese workmen under the supervision of American and German engineers. The university being five miles from a railroad and in a country where there are few facilities for moving heavy machinery, the apparatus had to be delivered partly by boat and partly by carts drawn by coolies. In selecting the equipment, cheapness was not the first consideration, but rather its adaptability for testing purposes.

The present equipment consists of two Babcock & Wilcox boilers; two Buffalo Forge Co.'s engines direct-connected to two 110-volt 15.5-kw. Siemens-Schuckert generators; a storage battery, with booster; an indirect heating plant for the main building of 25 rooms, and a steam pump, air compressor and motor-driven centrifugal pump for the water system, together with the usual auxiliaries.

There are over 40 buildings to be supplied with light and water, and the power house is placed in a central position with the apparatus for the water system beside it. Fig. 1 is a general view of the plant.

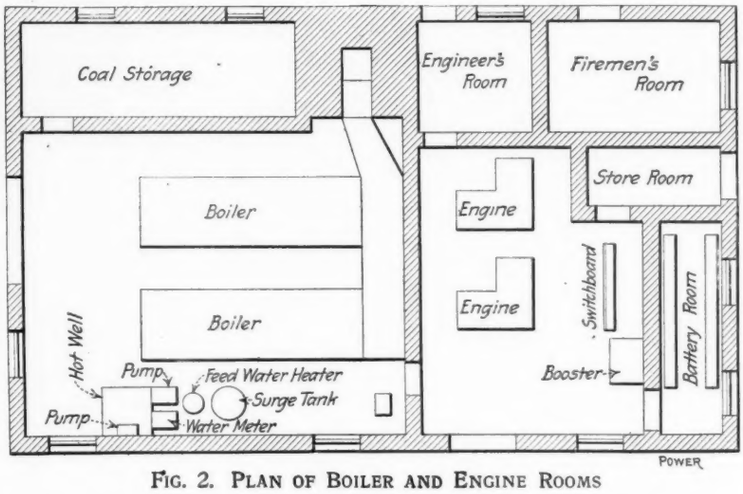



FIG. 2. PLAN OF BOILER AND ENGINE ROOMS

### WATER SYSTEM

The river water is pumped by a motor-driven centrifugal pump having a capacity of 265 gal. per minute, through a 3-in. pipe line 800 ft. long to the sludge well. Here it passes from the bottom to the top of the well through a screen of copper netting. At the top it flows to one of two settling tanks, and after settling for one day it flows to the sand filters. There are two of these sand filters, shown at *A*, Fig. 1, which are used alternately every month. From the filter the water flows by gravity to a concrete storage tank *B*.

The water is pumped from the storage tank by a single-cylinder steam pump, located in pump house *C*, into a steel pressure tank *D*, partly buried in the ground. This tank has a capacity of 20,000 gal. and an air pressure of 35 to 40 lb. per square inch is maintained within it.

A direct connection between the storage tank and the pressure tank is provided for use in case the main steam pump breaks down. In such a case the pressure on the steel tank is removed and water will flow into it by gravity. After the water level in the two tanks is the same the valve between them is closed and the pressure is produced by pumping air with the air compressor. On the other hand, if the air compressor breaks down, pressure can be maintained on the system by the main steam pump.

The distribution system is laid under ground, and hydrants are provided for use in case of fire. When a fire does occur the pressure tank is cut off from the distribution system and the main pump is used to produce a water pressure of 80 lb. per square inch.

The maximum capacity of the system is 50,000 gal. per 24 hours, which is determined by the amount of water that can pass through the filters properly.

A plan of the power house is shown in Fig. 2. The boilers are not placed in a battery as they were installed at dif-

ferent times. At one side of the boilers is a coal bin of 40 tons capacity, which is supplied through two windows from a platform outside. The coal is brought in bags weighing 200 to 250 lb. each, which are transferred from the carts to the bin by coolies.

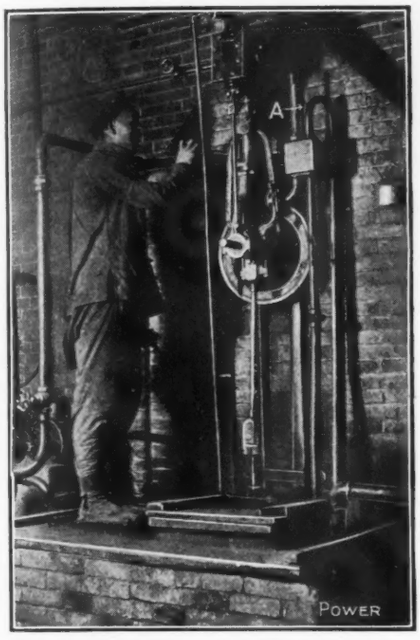



FIG. 3. FEED PUMPS

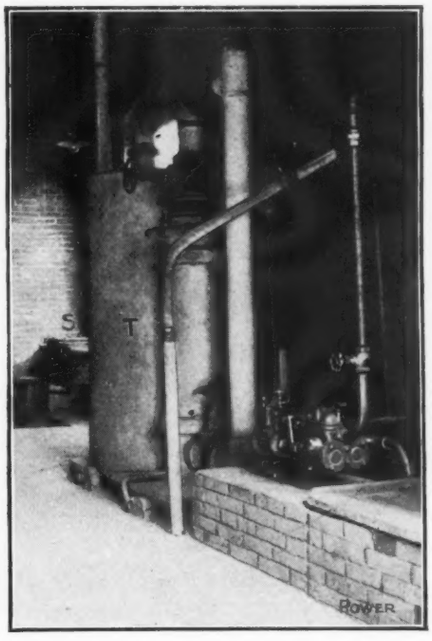



FIG. 4. SEPARATOR AND SURGE TANK

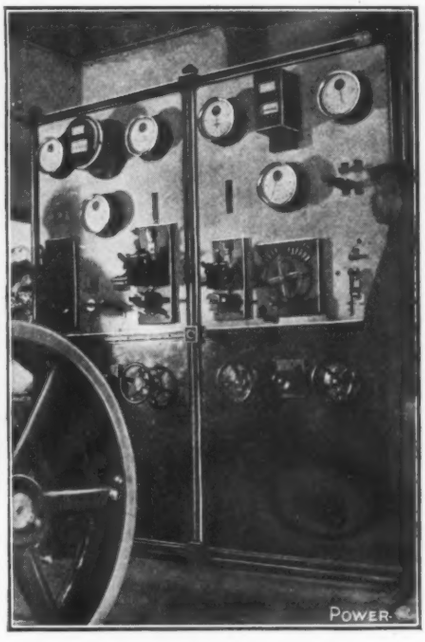



FIG. 5. SWITCHBOARD

### BOILERS

The boilers, which are of the standard Babcock & Wilcox type, were made in Glasgow, Scotland. Each is rated at 1600 lb. evaporation per hour and has 576 sq.ft. of heating surface. The working pressure carried is 110 lb. gage. It may be interesting to know that the safety valve is of the spring pop type with a lock on the spring, for when a Chinese fireman cannot keep his pressure up he ties down the safety valve, if possible, and then proceeds to make as large a fire as possible.

Bituminous slack costing about $1.75 a long ton is used, but owing to poor quality and poor firing, the average evaporation is only about 4 lb. of water per pound of coal. Each boiler is cleaned once every two months and, as a rule, no trace of oil is found and there is only about $\frac{1}{32}$ in. of very soft scale. This is easily removed.

Two feed pumps are installed, shown in Fig. 3. One was made by Alexander Young & Co., Ltd., of London, and is of the vertical, flywheel type, and attached to it there is a single-acting home-made pump placed below the water level in the hotwell. The bottom of the hotwell is 9 ft. below the boiler-room floor so as to receive the returns from the heating system.

A Eureka duplex steam pump is provided for use in case of a breakdown of the main feed pump. As it is placed above the level of the boiler-room floor it can pump only cold water.

The feed water is pumped through a Worthington meter and then passes to a closed heater.

The exhaust steam passes through the oil separator (*S*, Fig. 4), which is of German make and consists essentially of a baffle-plate with an oil- and water-separating tank attached to the drip. Sufficient cylinder oil is saved to lubricate the pumps. The steam next passes to a 30-in. surge tank (Fig. 7), connected to which are the feed-water heater and the pipe leading to the heating system. An atmospheric exhaust is also provided with a back-pressure valve.

### ENGINES

The main units (Fig. 6) are 8x8-in. single-cylinder, center-crank, high-speed engines direct-connected to the generators, and run at 350 r.p.m. An interesting thing about the engines is the fact that the generators and engines were never put together until they were placed on the foundations in the power house. The entire base was sent from America and the generator fields, outboard bearings and armatures came from Germany.

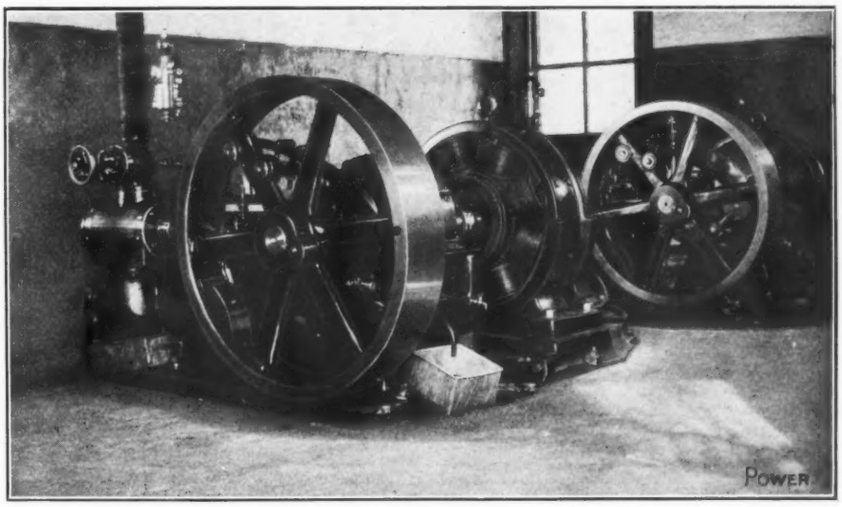



FIG. 6. MAIN GENERATING UNITS

These fitted exactly on one engine and the other merely required a little chipping and filing before fitting properly.

### ELECTRICAL EQUIPMENT

The plant has a storage battery of German make which supplies current during the day and after midnight. The

battery consists of 62 cells and has a total capacity of 54 amperes for 3 hr., or an ampere-hour capacity of 162. The charging is done through a booster set. The entire control of the storage-battery voltage and the booster set is from the switchboard. The last 13 cells of the battery are used as regulating cells and are each direct-connected to the switchboard.

The switchboard (Fig. 5) consists of two marble panels supported on an iron-pipe frame. One panel is used for the generators and the other for the storage battery. The feed-line fuses and the control switches are placed on a special panel, which is attached to the wall in back of the switchboard. The generator panel is of standard construction having a voltmeter with a three-way switch, an ammeter for each generator, a regulating resistance for each field, a wattmeter to register the entire output of the plant, a circuit-breaker for each generator, and fuses for protecting the armature. It is considered better to rely on fuses than on automatic devices as the labor is unskilled and the writer has caught the engineers tying the starting lever of a motor in the operating position rather than repair the magnet so that it would hold the lever.

## Heating System

The main building of the university is about 200 ft. distant from the power house and is heated by both live and exhaust steam, the live steam being supplied to the surge tank through a reducing valve.

The low-pressure steam flows through a 3½-in. pipe from the surge tank to the building, this pipe being in a trench placed from 2 to 4 ft. underground. The trench is lined with ordinary brick laid in lime mortar, and a large brick slab is used to cover the trench before the earth is thrown over it. The pipe is supported every 10 ft. on a double-decked cast-iron roller support, the support being made double in order to hold a high-pressure steam pipe that supplies steam to the laboratories. The two pipes are covered with poultry netting which is then plastered with a mixture of lime and graphite. The pipes have a slope of 1 in. in 10 ft. away from the power house.

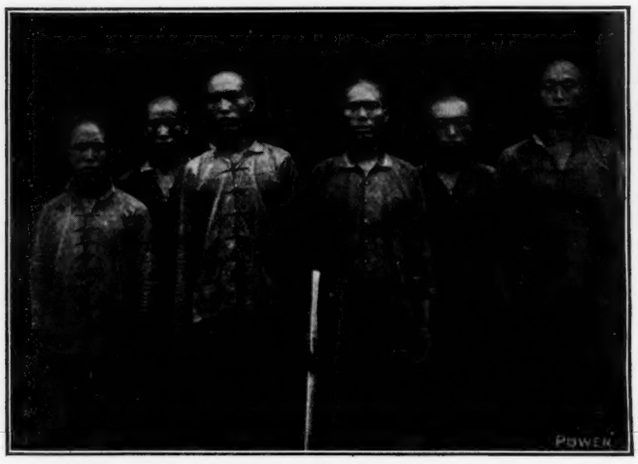


Fig. 7. Operating Force

Fig. 8. Showing Method of Bending Pipe

As a 90-deg. bend was necessary 200 ft. from the power house, the expansion joint was placed at that point, the pipe being anchored at the power-house end. Inside the building the pipe is drained by a trap and then rises nearly to the basement ceiling. It then continues along the basement for another 200 ft. with an expansion joint at the further end. In the basement the pipe is insulated with asbestos pipe covering. Each heating coil is supplied with one gate valve and an automatic and hand air valve. The condensation passes through a trap into the return pipe. The return is a 2½-in. galvanized-iron pipe buried 6 ft. below the ground, no expansion joint and no insulation being employed.

When this heating system is first started in the fall there is excessive condensation, but after operation for 24 hours there is not more than 1 lb. drop in pressure between the surge tank and the heating coils. During the winter, when snow is on the ground, it does not melt over the pipe trench. The winters in north China are very dry so that no trouble is experienced, because the dry earth acts as an insulator.

Small stoves are used in the pump houses in winter to prevent freezing. The pressure tank has never frozen and is

**Power Plant—Pei-Yang University—Tientsin**

*Daily Log.* *Date*_____

| Time | SWITCH BOARD: Volts | Kilowatt hours | Amperes Dynamo No. 1 | Amperes Dynamo No. 2 | BOILER AND ENGINE: Boiler Pressure lbs. per sq. in. | Exhaust Pressure lbs. per sq. in. | Steam Pressure at engine lbs. per sq. in. | Water meter cu. ft. | Temperature of feed water °F. | STORAGE BATTERY: Charging Volts | Charging Amperes | Discharging Volts | Discharging Amperes | Discharging Kilowatt hours |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Noon. | | | | | | | | | | | | | | |
| 12.30 | | | | | | | | | | | | | | |
| 1.00 | | | | | | | | | | | | | | |
| 1.30 | | | | | | | | | | | | | | |
| 2.00 | | | | | | | | | | | | | | |
| 22.30 | | | | | | | | | | | | | | |
| 23.00 | | | | | | | | | | | | | | |
| 23.30 | | | | | | | | | | | | | | |

Kilowatt hours used_____ Water Meter_____ cu. ft. Kilowatt hours from storage battery_____

Weight of coal { Lighting_____ Heating_____ Total_____

Weight of ashes_____

PROFESSORS' HOUSES METERS

(1.) (A. B. Morrill)_____
(2.) (J. A. Crane)_____
(3.) (E. A. Sperry)_____
(4.) (I. L. Sharfman)_____
(5.) (R. V. A. Mills)_____
(6.) (W. G. Bateman)_____
(7.) (R. T. Evans)_____
(8.) (W. H. Adams)_____

Break downs_____

New lamps supplied_____

New carbons in arc lamps
Clock Room_____
Class Rooms_____

Specific Gravity of solution after charging_____

Specific gravity of cells 8 A. M.

| Sp. Gr. | Number of cell. | Eng. oil Cyl. oil Remarks |
|---|---|---|
| 1.2000.. | | |
| 1.1975.. | | |
| 1.1950.. | | |
| 1.1925.. | | |
| 1.1900.. | | |
| 1.1875.. | | |
| 1.1850.. | | |
| 1.1825.. | | |
| 1.1800.. | | |
| 1.1775.. | | |

Fig. 9. Daily Log Sheet

not protected in any way where exposed above the ground. The lowest temperature is a few degrees below zero and the average winter temperature is about 15 to 20 deg.

### Operation

An interesting part of the power house is the space occupied by the engineering force as living rooms. There are six men on the force. The chief engineer lives in the room marked "engineer's room," in the plan, his furniture consisting of a table and a bed, the latter made of two sawhorses with planks laid across them. All the other men are supposed to sleep in the firemen's room. Generally, however, these men move their beds to the top of the boilers in winter and sleep outside in summer. Their food, consisting mainly of rice, is brought to them three times a day from the university kitchen by a coolie. Each man pays the university cook about $1.50 a month for his food.

The operating force is shown in Fig. 7. Beginning on the left, the first man is a coolie whose duty it is to clean and look after the regulating valves on the water system; next is a fireman, then the second assistant engineer; the fourth is the chief engineer, the fifth the other fireman and on the end is the first assistant engineer.

The chief receives $14.70 a month; the first assistant $8.40, the second assistant $3.80 and the firemen $5.10 and $4.20 respectively.

Careful records have been kept ever since the plant was started. All the coal is weighed and the water and wattmeters are read every day. Fig. 9 shows the daily log that is filled in by the chief engineer.

The cost per kilowatt-hour is high as the plant does not operate more than six hours a day, except when used for heating. When the generators are not in operation, current is supplied from the storage battery. Street lamps on the university grounds are lighted all night, but the light is cut off from student dormitories and university buildings at 11 p.m. This is necessary as the Chinese at the university will use a light all night even when sleeping. The engines are used on alternate nights and the boilers are alternated every two months.

At present, most of the apparatus is in duplicate as only half is used at a time. There are three reasons for this: first, the present load is smaller than was estimated due to tantalum lamps being used instead of carbon; second, a partial duplication was allowed to prevent a complete shutdown of the plant, and, third, provision was allowed for the future expansion of the university.

Without allowing for interest and depreciation but including all repairs, lamp renewals and new carbons in the arc lamps, the cost has varied from 4½ to 7½c. per kilowatt-hour. This is high, but the cost of supplies is excessive and the number of hours of operation is small.

Fig. 8 shows two of the men bending a 4-in. pipe for the water system, it being necessary to put a double bend for an offset of 4 in.

The water system cost $8160; the power house and the chimney $3336; the boiler-room apparatus and the heating plant, $7800; and the engines and electrical apparatus, $4165.

## The Unit of Heat

In response to our inquiry as to whether the heat unit had ever been legally defined or a standard unit adopted in the United States, Director S. W. Stratton, of the U. S. Bureau of Standards, writes as follows:

The British thermal unit has never been legally defined, nor have any international congresses, in their various steps toward properly defined and definitely related units of measurement, given any consideration whatever to this one.

Wherever it has been employed as a unit of heat it has been understood to mean simply the quantity of heat required to raise the temperature of 1 lb. of water through 1 deg. F., leaving the particular degree to be specified, if necessary, by the writer publishing the data in terms of such unit. The total variation of the specific heat of water between the freezing and boiling points being only about 1 per cent., and the difference in the heat units most likely to be used being but a small fraction of this, as set forth later, it must be assumed that when the term B.t.u. is employed without specifying any temperature at the same time, the data given are without significance in the figure where a consideration of this point would make an appreciable difference.

In very few, if any, cases where the B.t.u. has been employed in publishing data, has the work been of a nature to warrant the refinement of specifying the temperature. For the sake of comparison with the important work along the same lines in Germany, France and all other countries using the international metric system, aside from the advantage of the greater convenience in employing it, it is becoming more and more common in America to state heat measurements in terms of the units of this system, just as electrical measurements have from the very first been so stated.

The scientific unit of heat is called the calorie and is defined as "the quantity of heat required to raise the temperature of one gram of water through one degree Centigrade," the mean temperature of 15 deg. C. (= 59 deg. F.) being understood whenever no other is clearly specified. From time to time other units have been proposed, but they have not attained wide acceptance and when employed, they are clearly indicated.

From probably the best work so far done upon the variation, with temperature, of the specific heat of water, the following values are quoted:*

In terms of the 15-deg. calorie as a unit for comparison, the 4-deg. calorie = 1.004 15-deg. calories. 4 deg. C. = 39.2 deg. F. (The 4-deg. calorie has been proposed because of the maximum density of water occurring at about this temperature.)

The 15-deg. calorie = 1 15-deg. calorie. 15 deg. C. = 59 deg. F.

The 20-deg. calorie = 0.999 15-deg. calorie. 20 deg. C. = 68 deg. F. (The 20-deg. calorie has been proposed on the ground that a mean temperature about that of the usual laboratory possesses decided advantages.)

The 25-deg. calorie = 0.999 15-deg. calorie. 25 deg. C. = 77 deg. F. (This calorie was proposed as advantageous because from 20 to 30 deg. the extreme variation is but a few parts, probably 2 in 10,000, whence no careful temperature precautions would have to be taken in work involving a direct employment of the unit.)

The mean 0 to 100-deg. calorie = 1.0044. 15-deg. calories. 0 deg. C. = 32 deg. F.; 100 deg. C. = 212 deg. F. (This calorie is independent of the temperature scale, gas, mercurial, resistance, etc., since 0 and 100 deg. are always fundamental points.)

By the definition of the Fahrenheit scale and the internationally fixed Centigrade scale, the ratio of the two degrees is 1.8. The legal definition of the pound in the United States defines it to be a certain fraction of the international kilogram, the decimal value of which fraction to five figures makes 1 lb. equal to 453.59 grams. With the same mean temperature, 1 B.t.u. is therefore 252.0 calories, or

| | |
|---|---|
| One B.t.u. (59° F.) | = 252.0* 15° calories† |
| One B.t.u. (62° F.) | = 251.9* 15° calories |
| One B.t.u. (39° F.) | = 253.0 15° calories |
| One B.t.u. (32° to 212° F.) | = 253.0 15° calories |

The unit of heat officially used in this bureau is the 15-deg. calorie. Upon request, data are sometimes expressed in terms of British thermal units, the mean temperature of the unit employed being stated when the precision of the data requires differentiation. The 60- or the 62-deg. F. B.t.u. (being for all practical purposes identical with the 59-deg. F = 15-deg. C. one) is probably more often used by the bureau than any other.

*Bousfield & Bousfield, Phil. Trans., Royal Society, series A, Vol. 211, page 199, 1911. "The Specific Heat of Water and the Mechanical Equivalent of the Calorie at Temperatures from 0° C. to 80° C.

†These are the small or gram calories.

# Comparing Turbo-Pumps, Blowers

By Charles A. Carpenter

**By means of reducing to a basis of unit speeds, various types of direct-connected turbo-pumps and blowers may be compared for the purpose of selecting the most economical unit.**

Under general operating conditions for low head, the speed corresponding to the best efficiency on the driven unit is far below the most economical speed of the turbine. Consequently, the introduction of a higher-speed pump or blower is a progressive step of interest to the engineering profession.

How far an increase of speed may be carried without passing safe rotative velocities can be judged by noting, for example, that for circulating service requiring 20,000 to 30,000 gal. per minute against a 20- to 50-ft. head, 600 to 1000 r.p.m. is considered a high speed. The horsepower here is far below that of turbo-alternator sizes, easily running at 3600 r.p.m. Turbine-driven boiler feed pumps of large horsepower often operate at speeds of over 3000 r.p.m. Thus a very revolutionary advance in low-head pump or blower speeds would be needed to cause alarm from rotative velocities.

The design of centrifugal machinery, including water turbines, pumps, blowers, etc., is governed by laws quite thoroughly understood by engineers. By means of these relations, a comparison of various types of pumps for turbine drive may be made by reducing all to the condition of unit head and unit water horsepower, and noting the corresponding speed in revolutions per minute.

Briefly, these laws, at constant efficiency within limits for machinery of homologous design, are:

(1) The speed is proportional to the square root of the head.

(2) The power is proportional to the three-halves power of the head.

(3) The power varies as the square of the impeller diameter.

(4) The speed is inversely proportional to the diameter.

Let

$N$ = Speed of the pump;
$P$ = Water horsepower;
$D$ = Diameter of impeller;
$h$ = Head;
$h_1$ = Unit of head = 1 ft.;
$P_u$ = Unit of power = 1 water horsepower;
$N_1$ = Speed of impeller at 1 ft. head;
$P_1$ = Power of impeller at 1 ft. head;
$D_u$ = Diameter of homologous impeller developing a unit water horsepower at 1 ft. head;
$K$ = A factor representing the speed of a similar impeller developing 1 hp. at 1 ft. head.

Stating the foregoing laws algebraically,

$$N_1 : N = \sqrt{h_1} : \sqrt{h} \qquad (1)$$

$$P_1 : P = h_1^{\frac{3}{2}} : h^{\frac{3}{2}} \qquad (2)$$

$$P_1 : P_u = D^2 : D_u^2 \qquad (3)$$

$$N_1 : K = D_u : D \qquad (4)$$

Rearranging these expressions,

$$N_1 = N\sqrt{\frac{h_1}{h}} \qquad (1)$$

$$P_1 = P\left(\frac{h_1}{h}\right)^{\frac{3}{2}} \qquad (2)$$

$$D_u = D\sqrt{\frac{P_u}{P_1}} \qquad (3)$$

$$\frac{N_1}{K} = \frac{D_u}{D} \qquad (4)$$

Substituting equations (1), (2) and (3) in equation (4),

$$\frac{N\sqrt{\frac{h_1}{h}}}{K} = \frac{D\sqrt{\frac{P_u}{P\left(\frac{h_1}{h}\right)^{\frac{3}{2}}}}}{D} = \sqrt{\frac{P_u}{P\left(\frac{h_1}{h}\right)^{\frac{3}{2}}}}$$

Simplifying,

$$K = \frac{N \times \sqrt{P} \times h_1^{\frac{5}{4}}}{\sqrt{P_u} \times h^{\frac{5}{4}}}$$

If $P_u = 1$ hp. and $h_1 = 1$ ft.,

$$K = \frac{N \times \sqrt{P}}{h^{\frac{5}{4}}}$$

or

$$K = \frac{R.p.m. \times \sqrt{\text{water horsepower}}}{Head^{\frac{5}{4}}}$$

Since a water horsepower equals $\frac{Qh}{3960}$ when $Q$ is expressed in gallons per minute,

$$K = \frac{R.p.m. \sqrt{\frac{1}{3960}} \times \sqrt{Q}}{h^{\frac{3}{4}}}$$

Taking the revolutions per minute equal to 100 as a basis (then $K$ at any other speed is directly proportional) with $Q$ equal to 10,000, and converting to a logarithmic equation, the following is obtained:

$$log.\ K' = 2.2011 - \tfrac{3}{4}\ log.\ h$$

(Equation A)

The curves in Figs. 1 and 2 show the relations between the quantity in gallons per minute and $K'$ for various heads in feet of water. These are calculated similarly to equation A.

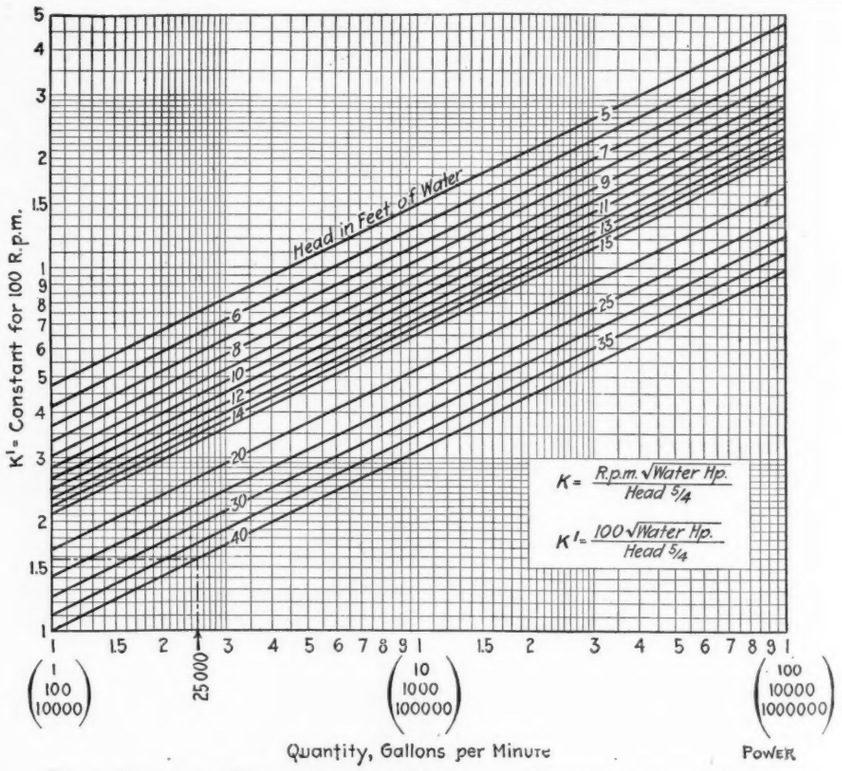



FIG. 1. CHART FOR PUMPS, SHOWING VALUES OF CONSTANT $K'$ FOR HEADS FROM 5 TO 40 FT.

Fig. 3 shows a similar relation between the quantity of air in cubic feet per minute and $K'$ for different heads in inches of water, where

$$K' = \frac{100\sqrt{air\ horsepower}}{Head^{\frac{5}{4}}}$$

Suppose an engineer wishes to correctly compare a number of pumps for some specific conditions; for example, 25,000 gal. per minute against a 40-ft. head. From the curves in Fig. 1 it will be found that conditions give a value of $K' = 15.8$.

Now suppose several pumps have been tested and the efficiencies obtained, also that the quantities have been substituted in the foregoing formula for the value of $K$. Let these be as follows:

| Pump | $K$ | Efficiency |
|---|---|---|
| A | 174 | 60 |
| B | 147 | 55 |
| C | 124 | 60 |
| D | 118 | 69 |
| E | 134 | 70 |

Reducing all to 25,000 gal. at a 40-ft. head, it would be right to expect speeds, as follows:

$K$ for pump $A$ = 174

$K'$ at 100 r.p.m. = 15.8

But,

$$K = \frac{R.p.m. \sqrt{water\ horsepower}}{Head^{\frac{5}{4}}}$$

and

$$K' = \frac{100 \sqrt{water\ horsepower}}{Head^{\frac{5}{4}}}$$

Hence

$$\frac{K}{K'} = \frac{R.p.m.}{100}$$

Therefore, the revolutions per minute for the given conditions equal

$$\frac{100 \times K}{K'} = \frac{100 \times 174}{15.8} = 1100$$

Taking data of a well known turbine, at random steam conditions, the water rates corresponding to the speeds are as shown, and with the efficiencies given, the water rates in pounds of steam per water horsepower-hour are calculated as in the last column.

TABULATION OF RESULTS.

| Pump | $K$ | Speed | Pounds of Steam per Brake Horsepower-hour | Efficiency | Pounds of Steam per Water Horsepower-hour |
|---|---|---|---|---|---|
| A | 174 | 1100 | 40.5 | 60 | 67.5 |
| B | 147 | 930 | 45.5 | 55 | 82.8 |
| C | 124 | 785 | 51.5 | 60 | 85.8 |
| R | 118 | 745 | 53.5 | 69 | 77.5 |
| E | 134 | 850 | 49.0 | 70 | 70.0 |

Pump $A$ is thus seen to be best, although it is not evident from a consideration of the pump efficiencies alone.

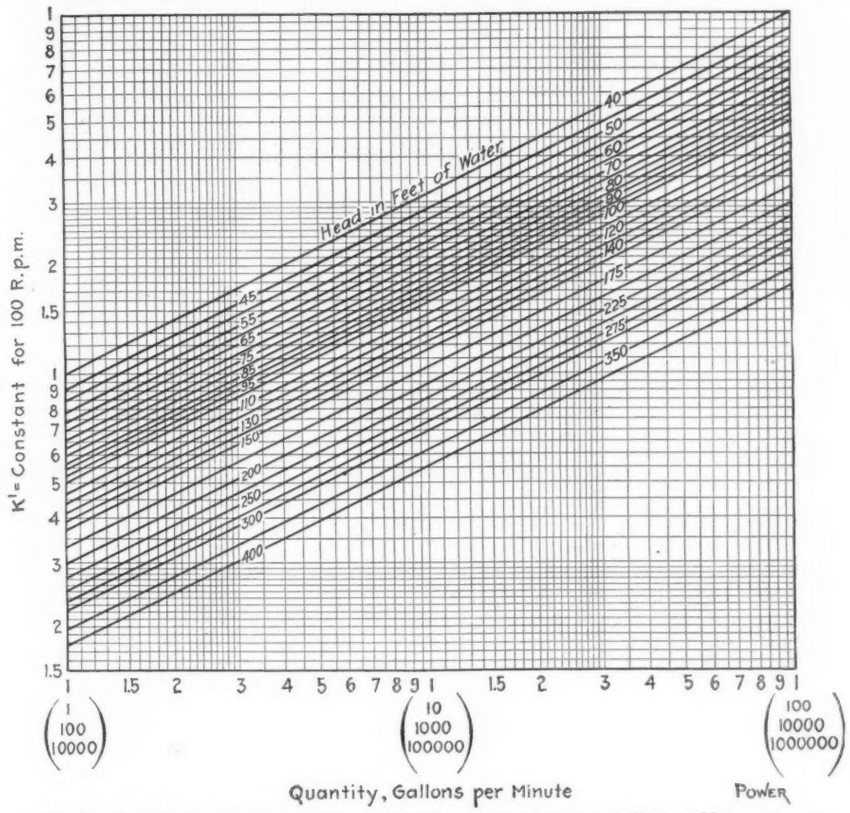



FIG. 2. CHART FOR PUMPS, SHOWING VALUES OF CONSTANT $K'$ FOR HEADS FROM 40 TO 400 FT.

## BLOWERS

The use of the curves for a blower problem will now be shown. Assume that it is desired to obtain 45,000 cu.ft. of air per minute at a pressure corresponding to 5.6 in. These conditions call for a constant $K'$ of 73.2 at 100 r.p.m. From the information given in a catalog and proceeding as in the case of the pump, it is found possible to obtain a constant of $K = 590$. It would then be possible to operate at 807 r.p.m. with an efficiency of 60 per cent., as shown in the following tabulations. For the given conditions, the turbine water rate would vary with the speed, as shown, and it would be known at once that 1 air horse-

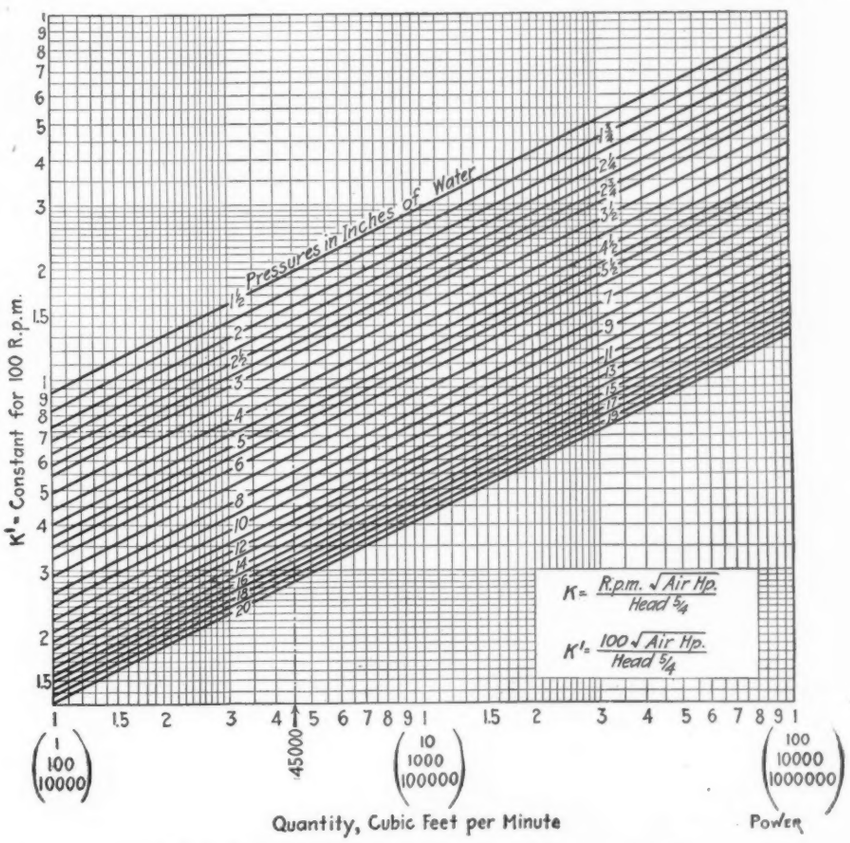



FIG. 3. CHART FOR BLOWERS, SHOWING VALUES OF $K'$

power could be expected for 133.3 lb. of steam per hour.

| No. | Speed | Pounds Steam per B.Hp.-Hr. | Pounds Steam per Air Horse-power-hour | Eff. Required | K' | K |
|---|---|---|---|---|---|---|
| 1 | 807 | 80 | 133.3 | 60 | 73.2 | 590 |
| 2 | 1000 | 70 | 133.3 | 52.5 | 73.2 | 732 |
| 3 | 1200 | 62 | 133.3 | 46.5 | 73.2 | 878 |
| 4 | 1500 | 54 | 133.3 | 40.5 | 73.2 | 1098 |

How much the efficiency could be sacrificed for speed to keep as good results is answered by the foregoing comparisons. The engineer would be inclined to investigate blowers of higher speed, and from Fig. 4 it will be seen that it is possible to better the economy shown by the standard blower *A*.

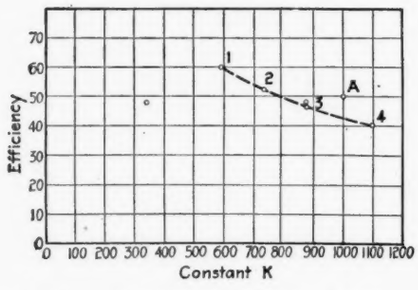



FIG. 4. BLOWER EFFICIENCY CURVE

In conclusion, the writer would urge all engineers buying, selling or operating centrifugal machinery to use such curves as shown in Figs. 1, 2 and 3 for calculating constants for operating conditions, and then to refer to the efficiencies as derived from tests for comparisons. Then, by taking data from one turbine builder, the best pump or blower for the work could be selected, leaving the selection of the turbine as a separate problem. There is no doubt that such investigation would bring to light the great value of larger constants *K*, or unit speeds as they are called, for turbine-driven units where low pressures are required.

The theory of unit speeds for water turbines is given in a paper by Chester W. Larner, entitled "Characteristics of Modern Hydraulic Turbines," and printed in the *Transactions* of the American Society of Civil Engineers, volume 66, page 306.

## Peculiar Steam-Engine Design

If one but had the time to hunt them up, many curiosities in engine and boiler designs could be brought to light. The textile mills in small towns are particularly notable in this respect, which is probably because such enterprises were originated by an individual, and that the power equipment has been made to do its work, even though it may be obsolete and uneconomical.

But when these enterprises fall into the hands of large companies, these obsolete designs of power units are discarded and modern equipment is installed. A notable example is shown in the accompanying illustration which pictures an old-time steam engine that was installed at the Dutchess mill of the Garner Print Works, Wappinger Falls, N. Y. At this plant extensive alterations are being made in the power equipment, an electric drive being installed and the old steam installation being discarded as fast as the improvements will permit.

In Fig. 1 is shown one of the engines on its original foundation. The steam valve-gear mechanism is placed above the steam chests, which are on the inside of the cylinder, and each valve-gear and cylinder is equipped with a separate governor.

In Fig. 2 is shown a near view of the valve-gear and the governor. A close examination shows that as the governor balls rotate, in a higher plane than shown, the arm attached to the fly-ball arm will force the governor spindle down, and, through lever connections, move the rod, which extends to either end of the cylinder, in and out, thus actuating a catch-block arm, and regulating the cutoff as the load varies.

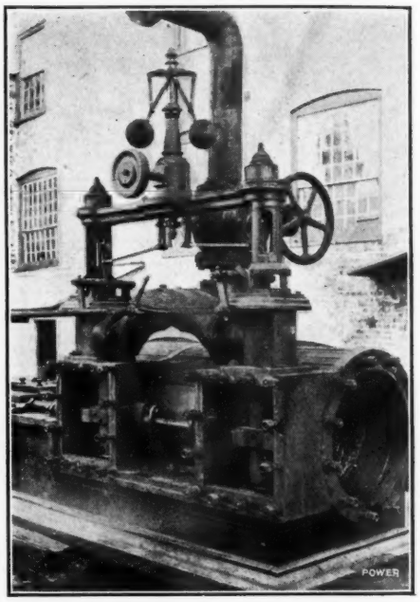



FIG. 2. VIEW OF THE VALVE GEAR

The valve-gear is operated by means of an eccentric and detachable reach rod. As the crank at each end of the cylinder is moved back and forth it engages and becomes disengaged with the catch block on the valve stem, and being under the control of the governor, steam is thus admitted to and cut off from the steam cylinder. The two D-exhaust valves are operated by a single eccentric and valve stem, both valves being attached to the same stem as indicated.

It is unfortunate that the writer was not able to view this interesting engine before it had been demolished, in order that a more comprehensive description of the valve-gear and its operation could have been obtained.

If any of our readers are familiar with this old type of engine it would be interesting to have more detailed information on its design and operation.

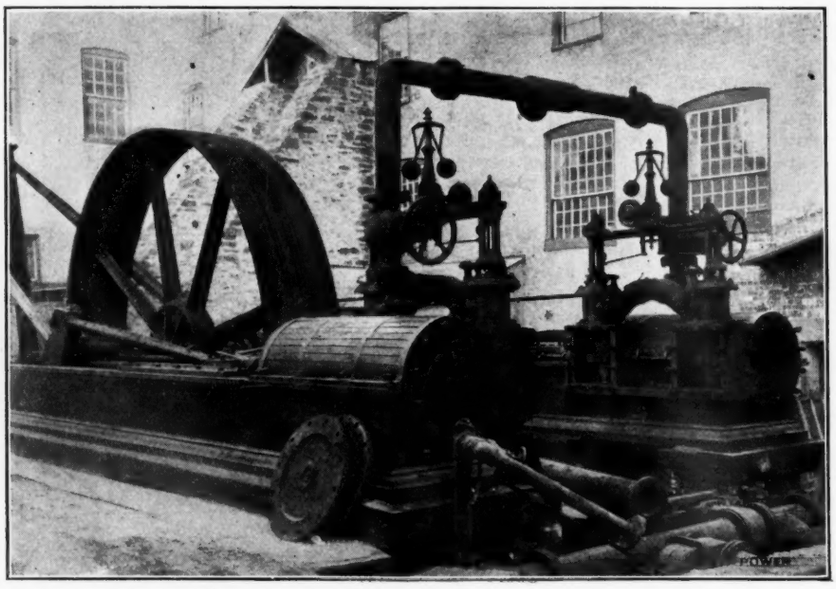



FIG. 1. ODD MAKE OF ENGINE RECENTLY DEMOLISHED

It is the policy of the University of Toronto to compel its mechanical and industrial students to spend at least eight months' actual work in manufactories under workmen's conditions. Training given in university shops, it is contended, falls short of fulfilling the practical requirements when the student enters the field of actual endeavor.

# Combined Ash and Coal Storage

By W. O. Rogers

**Coal and ash are handled by the same conveyor.**

**The coal bin consists of two sections, one having a capacity of 1000 tons, the other 250 tons; the large bin holds an emergency supply.**

**Another bin holds the ashes until a carload has accumulated.**

One of the interesting features of the Hazard Manufacturing Co.'s new plant, Wilkes-Barre, Penn., a description of which was published in a recent issue, is the manner in which the coal and ashes are handled.

### Coal Bins

Facing the boiler front is a concrete partition, behind which a coal bin has been constructed. This bin is made in two sections; one is for the storage of coal, the other to contain coal that is for immediate use. The upper section, which is located midway of the bin, has a slanting bottom, so that coal will flow by gravity through a chute into a weighing machine that runs on a suspended track in the boiler room.

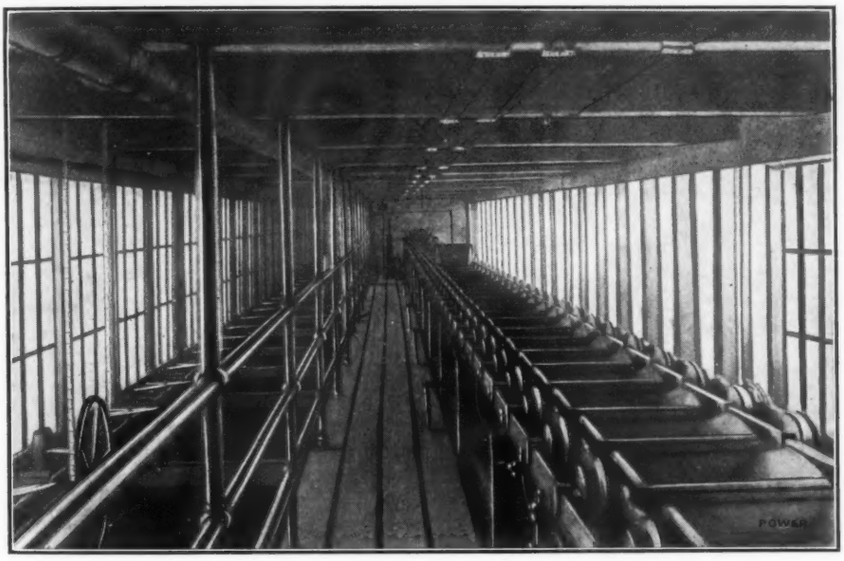


Fig. 1. Conveyor in Monitor over Coal Bin

The main bin is 15 ft. wide, 96 ft. long and is 40 ft. high at the far end and 20x30 ft. on the section of the second bin. This upper bin is supported by six 9-in. iron columns surrounded by cement, making the columns 11 in. square. The coal from the upper or small bin is carried to the coal weigher by means of a coal chute. When the weigher is full it is pushed to whatever boiler requires fuel and the contents dumped on the floor; then it is hand fired to the furnaces. At the bottom of the main storage coal bin in the basement are openings through which the coal can be obtained and supplied to the conveyor which runs under the concrete floor. The coal is thus elevated and dumped into the smaller bin.

This is not the regular practice, but the arrangement has been provided so that in case the coal supply in the smaller bin runs short, or the shipment of coal is delayed, the reserve supply can be drawn from to tide over the emergency.

As the bottom of the coal bin is on a level with the basement floor, the same openings to the conveyor that are used for disposing of the ashes are used in transferring the coal from the large to the small bin.

### Conveyor

The conveyor machinery consists of a 10-hp. induction motor operating on a 440-volt circuit, and is located in the monitor over the boiler room. It drives a bucket conveyor consisting of 162 buckets; these are capable of handling 40 tons of coal per hour. It is shown in Fig. 1. The tripping or dumping device is, under ordinary conditions and circumstances, so placed that the buckets will dump their loads into the small or 250-ton coal bin. There are four dumping devices over the 1000-ton storage bin.

At the far end of the coal bin a separate compartment has been built in which the ashes are stored. From this bin the ashes are loaded into wagons on cars and are conveyed away; wagons are mostly used.

The coal is brought to the plant by rail and is unloaded through the bottom of the cars into a concrete hopper built under the track surface, the coal passing through a grating to prevent foreign substances from going in with the coal supply. The bottom of the hopper is fitted with a spout, as shown in Fig. 2, and the coal is allowed to run through this spout to fill the buckets, when it is conveyed to either of the two

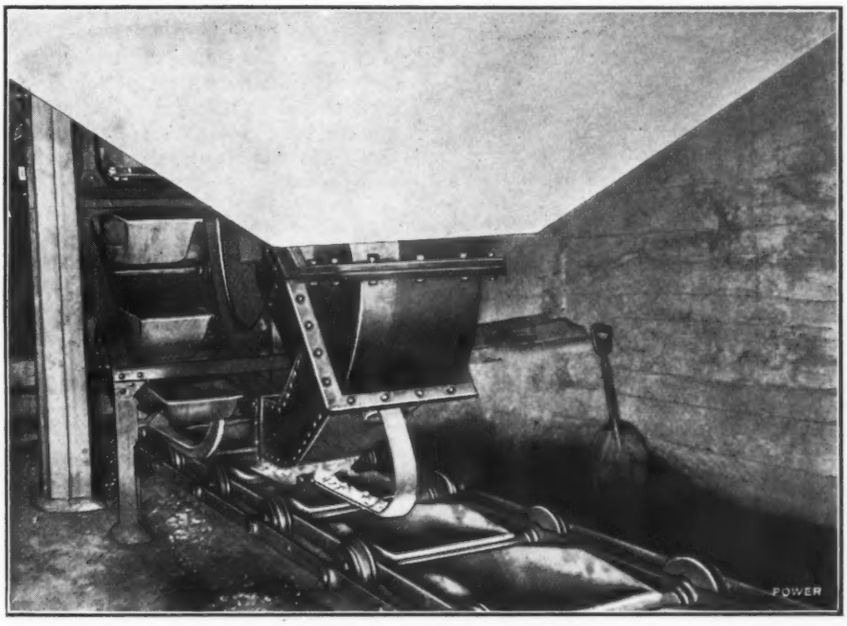


Fig. 2. Hopper through Which Coal Is Unloaded from Coal Car into Conveyor

coal bins. A general view of the coal bins and boiler room is shown in Fig. 4.

### Handling the Ash

In Fig. 3 is shown the general arrangement of the basement and the method of handling the ashes from the ashpits of the boilers located on the floor above.

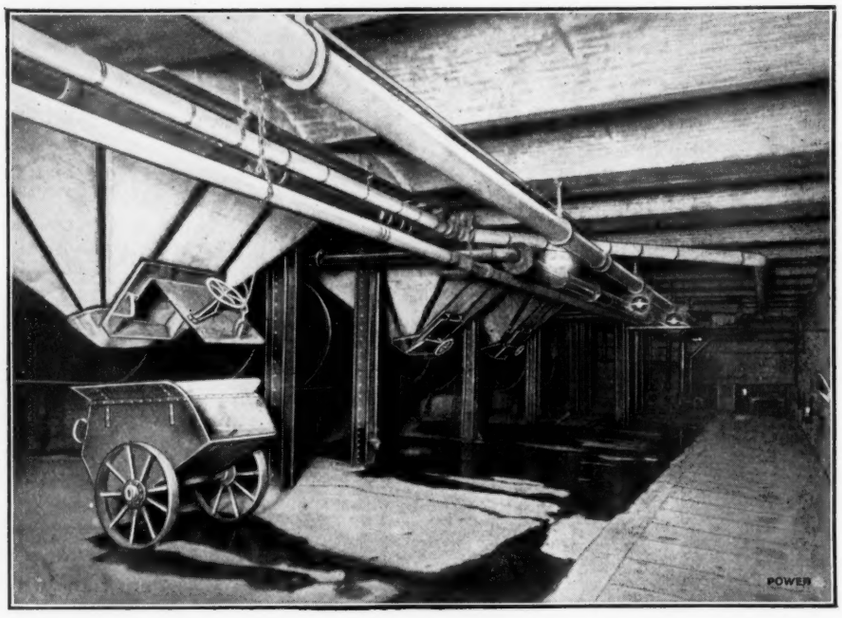


Fig. 3. Ash Hoppers under Boilers, Ash Cart and Concrete Flooring above Conveyor

Under each ashpit there is a concrete storage receptacle with a slanting bottom, on one side of which is a metal door over the discharge outlet. This ashpit is built so that an ash cart can be run under it as shown. When it is desired to remove the ashes from the ashpit under any particular boiler, the cart is placed under the opening in the bottom and the door is opened, when the ashes run into the cart.

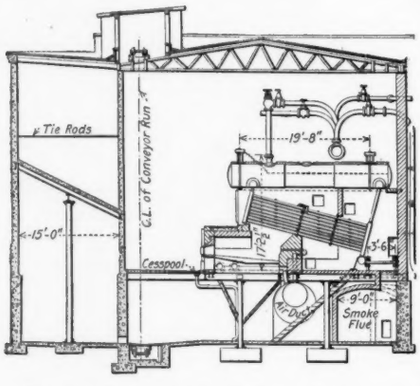



Fig. 4. Elevation of Coal Bins and Boiler Room

The load is then wheeled to the concrete flooring over the conveyor, dumped and the ashes shoveled over the grated openings which are shown over the conveyor that runs under the concrete flooring. These openings are supplied with covers, so that when ashes are not being conveyed the floor presents a smooth surface and any danger of injury from falling into the opening is avoided.

The basement concrete flooring is slanted so that all drippings flow to a sewer and thence to a sump or cesspool. After the ashes have been moved, the floor surface is washed off with a hose, leaving the basement clean and neat.

A feature of the ash conveyor is that the concrete flooring has been built over the conveyor tunnel, so that it overlaps the buckets and there is no chance of the ash and clinker getting into the wheels and bearings of the conveyor. The buckets cannot be overloaded, as a scraper plate has been arranged so that if one bucket gets too much the top surface is scraped off into the next bucket and the load is thus equalized.

## Repairing Condenser Tubes at Cuban Plant

By F. H. Colvin

One of the large power houses of the Havana Central Ry. is located at Luyano, a few miles distant from Havana. This is a turbine plant of 5000 kw. capacity containing several large surface condensers.

Owing to local conditions, frequent renewals of condenser tubes are necessary, and as the tubes cost $2 each, delivered to Havana, this proved to be a serious item of expense. Consequently the company set about to devise a method of repairing the tubes themselves, by cutting off the damaged ends and brazing a new piece to the good portion of the tube.

For this purpose a gas torch is employed, air pressure being supplied by a foot-operated bellows shown at the bottom of the tank in Fig. 1. The tank acts as a reservoir to maintain the air supply under pressure. The small stovepipe at the back provides a place for the torch when not in actual use for brazing.

The ends of the tubes are scarfed in the same way as when repairing boiler

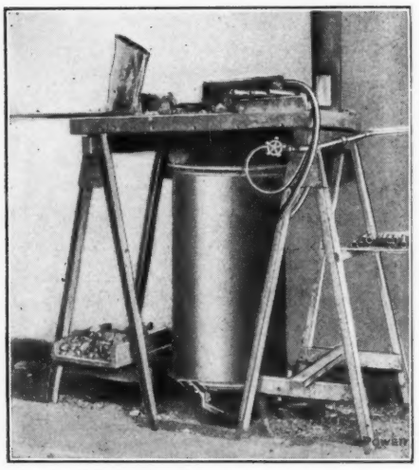


Fig. 1. Brazing Outfit Complete

tubes and the piece to be brazed on is clamped as shown, so that the end projects over a bed of fireclay (see Fig. 2). The tube to be repaired is held in position against the new piece while the flame from the torch is applied, keeping the temperature at the brazing point. The usual brazing spelter is used.

Fig. 2. Tube in Process of Brazing

The operator has become so efficient in the use of this device that instead of the company being compelled to buy new tubes at $2 each, the old ones are repaired at a cost of about $34 per thousand.

# The Smoke Abatement Conference

**At the International Smoke Abatement Exhibition and Conference, held in London from March 23 to April 4, papers were read by representatives from the world's manufacturing centers, showing what is being done in different localities to overcome the smoke nuisance.**

**A full line of exhibits was shown, covering smoke consumers, mechanical stokers and various domestic appliances.**

The International Smoke Abatement Exhibition and Conference held in London on Mar. 23 to Apr. 4 marked another step in the campaign which is being carried on along educational lines for abolishing the smoke nuisance. Within the past few years a number of similar conferences have been held in the United Kingdom, bearing largely upon local conditions. This conference, however, was international in scope; papers were read by representatives from a number of manufacturing centers in different countries and an opportunity was offered for comparing the various means by which the smoke nuisance is being combated.

The exhibition covered all classes of factory and domestic appliances for minimizing or reducing smoke. Although the exhibits relating to household smoke, due to their popular character, somewhat overshadowed those relating to factory smoke, there was, nevertheless, a creditable exhibit of mechanical stokers, gas producers and smoke-consuming devices. Among the latter were a number of devices for automatically controlling the secondary air supply.

The conference of delegates from local authorities and scientific societies was held on Mar. 26 to 28, and was attended by city councillors, medical officers of health, smoke inspectors and independent smoke reformers. It was stated by the secretary of the Smoke Abatement Society that 71 organizations were represented at the conference, 21 being delegates from the London Borough councils and 9 from foreign municipalities, in addition to which there were official representatives from the governments of Sweden and Holland. A program of 28 papers was arranged for the three days.

The nine papers read on Mar. 26 dealt with the effects of a smoke-polluted atmosphere, upon buildings, paintings, statuary and plants. Details relating to the injury arising from the soot, dust and acid vapors contained in the air, and to the best methods of preserving stone work, metal work and paintings, were given by Sir Arthur Church, H. Redfern, Mr. Ruston, Miss Agar and others. As Walter Reid (representing the Society of Chemical Industry) pointed out in the discussion, competent architects ought to choose their materials with regard to the atmospheric and climatic influences to which they will be exposed, and not indulge in marble and bronze combinations for the center of large cities.

On Mar. 27, sixteen papers relating to the work done in organizing preventive action and to the practical methods of securing the abatement of both domestic and factory smoke were down for reading and discussion. Reports upon the progress of the smoke-abatement movement in Germany, England and America were presented respectively by Herr Ing. Nies, of Hamburg, J. B. C. Kershaw, of Liverpool, and Thomas E. Donnelly, of Chicago. These reports illustrated the widely different methods of attacking the smoke problem in the three leading manufacturing countries. At the afternoon session the subjects of stoking, wasteful power production, and solid smokeless fuels were dealt with.

The "Present Law and Prospective Legislation Relating to Smoke Abatement" engaged the attention of the delegates on Thursday, Mar. 28, when four papers were presented dealing with this side of the subject.

The conferences ended on Thursday evening, Mar. 28, with the passing of a number of resolutions relating to (1) the proposed bill amending the existing laws in relation to smoke; (2) the adoption of a standard method of measuring the atmospheric soot and dust fall and of recording the density of smoke; (3) the education and training of stokers and the granting of certificates for efficiency in their work; (4) the appointment of a royal commission by Parliament for the purpose of inquiring into the whole subject of smoke abatement, and the amendment of the existing laws against smoke; and (5) the coöperation of smoke-abatement societies in other countries with the proposed inquiry of the Pittsburgh University into the economic aspects of smoke abatement.

### Abstracts of Selected Papers

"The Growth, Aims and Work of the Hamburg Smoke Abatement Society" was the title of a paper by Herr Nies, who stated that this society was founded in 1902, and is a voluntary association of fuel-users, located in and around the city of Hamburg. Its operations have been extended to cover a large part of the industrial districts in the neighborhood of Hamburg, and its work has been well received even outside of Germany itself.

The parent society has now 328 members who use boilers, besides 102 other members who support its work. The society controls 1345 boilers in the interests of its members, and there are three engineers and five instructors for stokers engaged in this work under the direction of a chief engineer. Boiler plants in Hamburg or its immediate vicinity are inspected three times a year, the object being to instruct stokers, to test the existing apparatus for the control of stoking, and to examine the structural conditions of the plant with regard to economy and smoke abatement.

As a rule, a written report is made for each inspection, covering suggestions for improvements and advising with regard to the purchase of fuel, procuring furnace parts, etc. Furthermore, a special chemical department has been created in Hamburg by the society for the chemical and calorimetrical examination of the fuel used.

Herr Nies then passed on to discuss the factors of most importance in the reduction of smoke, stating that the experience of the Hamburg society had been that it was not lack of temperature, but the inadequate air supply and lack of a proper mixture of this air with the gases given off by the burning fuel, that was the chief cause of factory smoke. It is for this reason, that with hand-fired boilers the society recommends the adoption of automatic devices for regulating the supply of air to meet the varying demands of the furnace.

The author concluded with the following plea for the formation of societies similar to the Hamburg society in other cities and countries:

> It is our endeavor to base the arguments for smoke prevention upon technical grounds. We do not wish to wait for the pressure of public opinion, aroused by a general propaganda for the abolition of smoke, but we wish to gain partisans for our views among technical men themselves, and the recognition on their part that a smoky chimney must now be considered as a symptom of inefficiency and bad management. No employer can desire that his works should be recognized externally as being badly managed. He will, therefore, in his own interests endeavor to remove a defect so plainly visible as the emission of clouds of black smoke, the more so when he is convinced that there is a remedy at hand which is in accordance with his economic interests. We look forward to a solution of the smoke question with the aid and coöperation of factory owners and not in opposition to their wishes or desires.

### Smoke Abatement in Germany

Dr. Kobbert, manager of the gas works at Königsberg, Germany, stated that the first real progress in the campaign against black smoke in Germany

dates from the promulgation of the Prussian State regulations on the subject. These were copied by all the other states of the German Empire. The next step in advance was the interest aroused by Dr. Ascher's investigation upon the relation between the purity of the air supply and the diseases of the throat and lungs, carried out in 1905 in Königsberg. This investigation led to a claim that the purity of the air-supply ought to be of equal importance to that of water supply and drainage, and to the founding in 1906 in Königsberg, of a society for smoke prevention which publishes annual reports upon the subject.

The following principles have been generally recognized in Germany as governing all attempts to minimize smoke: Chemical and calorific examination of the fuel ought to precede its selection for any purpose. The type of furnace and method of firing should then be chosen, with an eye to the cheapest and most easily transported coal available in the locality of the works where it is to be used. Having selected a type of furnace and fuel suited to one another, the question of the best method of supplying and regulating the primary and secondary air must be worked out by actual trials. For this purpose $CO_2$ testing apparatus must be installed, and if possible a continuous recording apparatus also, in order to indicate the smoke emission.

The importance of employing a thoroughly competent fireman was next touched upon, and the author stated that automatic apparatus for regulating the secondary supply must be installed when such a man is not available.

The difficulty of avoiding smoke with household fires and with bakers' ovens was next dealt with, and it was stated that these together cause the larger portion of the smoke in German towns and cities. It has been recognized in Germany, however, that there comes a point when the attempt to obtain the smokeless combustion of bituminous fuel becomes unprofitable, and that the only real solution of the bituminous smoke problem is to forbid its use for manufacturing or domestic purposes. This opinion favors the substitution of anthracite, coke or oil for bituminous fuel; or if the latter must be employed, the combustion of the volatile constituents of the coal, separate from the solid. The slow-combustion stove, burning coke, or the earthenware stove, burning coal, are both smokeless methods of heating houses. Hot-water heating is also being widely employed in Germany for dwelling-rooms and flats. The use of oil for heating purposes is extending.

### Recent Progress against Black Smoke in the United Kingdom

This was the subject of a paper by J. B. C. Kershaw, who contended that the most direct proof that the soot and dirt suspended in London's atmosphere were diminishing rather than increasing in amount, was to be found in the figures relating to the duration of fog in London, published in the 1910 report of the Coal Smoke Abatement Society. These figures, representing the annual averages for three successive periods of nine years each, are reproduced below.

| Period | Average per year. Days with fog |
|---|---|
| 1883-4 to 1891-2..... | 29.9 |
| 1892-3 to 1900-1..... | 20.7 |
| 1901-2 to 1909-10..... | 10.6 |

The steadily increasing purity of London's atmosphere indicated by these figures was confirmed by more recent figures obtained from Dr. Norman Shaw for the period 1902 to 1911. These showed a gain of 84 hours of sunlight per annum, and a reduction of 10 days for fog, when the averages for the two corresponding five-year periods were compared.

The author stated that the increased attention which was now being devoted by public authorities and voluntary societies in the United Kingdom to the subject of smoke abatement was most strikingly reflected in the extension of educational work, which was regarded by many as the most useful and hopeful line of attack upon the black-smoke evil. The classes for stokers, promoted by the Coal Smoke Abatement Society and started at the London Borough Polytechnic Institute in the winter of 1906-1907, had been followed by the inauguration of similar lectures in Glasgow, Liverpool, Manchester and other manufacturing centers.

To show how rapidly gas is displacing solid fuel for cooking and heating purposes, Mr. Kershaw cited figures from the *Gas World Year Book*, showing the increase in the total number of gas cookers in use in the United Kingdom during the period 1902-1912, to be 998,878 for 1902 and 2,921,299 for 1912, an increase of 1,922,421 in the 10 years. This, of course, does not include gas fires. Also the steel manufacturers in Sheffield have appointed a committee to investigate the possibilities of gas and electric furnaces, as substitutes for the smoke-producing reheating furnaces of that city.

In conclusion, the author drew attention to the fact that, although bituminous coal can be utilized now for all industrial purposes without the production of any smoke, by aid of well known appliances and methods of work, it by no means follows that changes will not be introduced into the methods of employing this type of fuel for heating and steam-raising purposes in the near future. He was of the opinion that the gas engine and oil engine will gradually supplant the steam engine as a prime mover, and with this change the burning of bituminous coal under steam boilers will give place to its utilization in the gas-producing plant. Gas-fired boilers and furnaces will also take the place of those now heated by solid fuel, and in this new development Prof. Bone's system of surface combustion will play a leading rôle.

### Smoke Abatement in America

Thomas E. Donnelly, chairman of the smoke-abatement commission of Chicago, stated that the active movement to improve the atmosphere of Chicago, as regards smoke contamination, dates from 1907, when the commission upon smoke abatement was appointed, with the author as chairman. The commission was composed of business men, and powers were obtained to inspect all plans of new power and heating installations, together with plans for the alteration of existing plants, and to reject them if it was considered likely that a smoke nuisance would be caused. The commission was also authorized to inspect and report upon all steam-raising and heating plants, and to make recommendations for their better working, if this appeared necessary.

When an owner proved obstinate about carrying out the suggested alterations, fines could be imposed, but as a rule it was not found necessary to resort to this.

The official staff of the commission consists of 22 engineers and clerks, with a numerous body of smoke inspectors. It is claimed that the smoke nuisance in Chicago has been reduced one-third, and in some individual cases by 75 per cent., as the result of the work of this commission—and the message from Chicago to the International Smoke Abatement Conference was that the smoke evil can be best attacked and abolished by administrative methods.

Another paper upon the smoke problem in America was read by J. A. Willard, of Boston. The author's remarks were confined specially to that region in which soft bituminous fuel is mined and sold, at the very low rate of about $2 per ton. From the eastern slope of the Rocky Mountains to the western slope of the Alleghany Mountains, railroads and all industries requiring power are forced to use bituminous coal. This coal is for the most part low grade, cheap and smoky.

The smoke conditions in all this region are atrocious. In the great manufacturing cities, such as Pittsburg, Chicago, St. Louis and Cleveland, the injury to health and property has been so great as to provide public inquiry into the causes of smoke, and determination on the part of the authorities, aided by public opinion, to reduce and finally end the nuisance.

In Boston there has been a constant fight for the prevention of smoke wherein the smoke producers have, up to 1910,

had all the advantage. In 1901, the Massachusetts legislature passed a law forbidding smoke from any source, but exempting locomotives. In 1902, this law was amended to exempt brick-kilns in addition to locomotives. In 1905 it was further amended by exempting all public-service corporations and wood-burning plants. In 1908 pottery-kilns were added to the exemptions. It will thus be seen that all the smoke-producing plants were exempt by law, the public being left unprotected and entirely at the mercy of the offenders.

The author then gives the history of the repeated attempts of the citizens of Boston to obtain some amendment of the law. Having failed in these attempts to obtain legislative action, the citizens' committee proceeded to gather evidence of the losses resulting both to the manufacturers and the community from the emission of black smoke, and of the practical methods by which these losses could be minimized. The sequel is best told in Mr. Willard's own words:

> It was definitely decided that so long as bituminous coal was used as fuel, the only relief from the smoke nuisance was in the education of the fireman, and that the management of a fire was as much a science as any other problem of chemistry. Armed with these facts, every smoke-producing industry was interviewed in the friendliest manner; the facts were exhibited, and today Boston can boast of as little smoke annoyance as any city of its size in America.

"Smoke Abatement in Pittsburgh" was discussed by Dr. R. C. Benner, of the Pittsburgh University, who began by stating that it is strange when one stops to consider the breadth of interest and importance of this problem, together with the fact that so many thousands have worked on its various phases and that so much has been written on the subject, that no coördinated effort of one group of men has been made to undertake a scientific study of the problem as a whole. This is the aim at the University of Pittsburgh. The author then described the various branches of investigation that are being pursued by the small commission of scientists who are undertaking the work. These include inquiries into the increased cost of living and the losses to manufacturers due to smoke, the relation of smoke to health, the effects of smoke upon plant life, the effects of smoke upon buildings, statuary and paintings, and the influence of smoke upon the meteorological data relating to sunshine and fog.

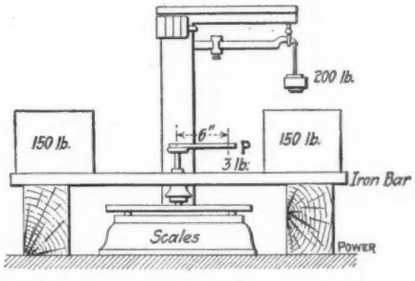
From this brief outline it will be seen that, while the investigation will be of great service to this locality under any conditions, still, if the coöperation of people in other parts of the world, likewise affected by this nuisance, can be secured, comparative results can be obtained which will enlarge the sphere of usefulness, not only to the immediate benefit of Pittsburg, but as well to that of the world at large.

## Abuse of Valves

By C. D. Eldredge

In our power-plant work we get together occasionally and discuss features of practical operation. During one of these engine-room conferences a fireman told of a man who had very powerful hands; he took particular delight in closing ordinary globe valves so tight that the stem would be twisted off in trying to open them, if he did not accomplish the same thing in closing the valve.

This incident set me to thinking about the power exerted by the screw and the pressure put upon the valve seat in ordinary practice. A simple experiment, which the sketch will make plain to the reader, was then performed. The stem and bonnet were taken out of a ¾-in. globe valve and fitted into a hole in an iron bar, which was placed over an ordinary platform scales as shown. Running the valve stem down till it touched the platform, a lever was attached to the handwheel and with a spring balance a pull $P$ of 3 lb. on a 6-in. radius was applied. This proved just sufficient to balance the 200-lb. weight on the scales, the screw having a pitch of $^1/_{11}$ in. Varying conditions make a wide difference as to the efficiency of the screw, and by actual




Measuring Force Applied to Handwheel of Valve

experiment in our case this efficiency was found to be unusually low. The following formula was used to determine the force exerted at the wheel:

$$W = \frac{2\pi rF}{P}$$

in which

$F$ = Force applied in pounds;
$W$ = Weight or pressure resulting;
$P$ = Pitch of screw;
$r$ = Radius on which force acts.

Substituting the numerical values in this formula gives

$$W = \frac{2 \times 3.1416 \times 6 \times 3}{\frac{1}{11}} = 1244 \text{ lb.}$$

$$\frac{200}{1244} = 0.16$$

or 16 per cent. efficiency of screw. A pressure of 200 lb. is surely enough to close a ¾-in. valve under ordinary conditions.

Taking the above example as a basis of calculation, it may be interesting to work out one or two more problems. The man who grips a ¾-in. globe valve and screws it down hard, applies the force on a radius of about 12 in., the length of the fore-arm, and suppose the force applied is 20 lb.; then the formula will give the following result:

$$W = \frac{2 \times 3.1416 \times 12 \times 20}{\frac{1}{11}} \times 0.16 =$$

2654 *lb.*

This would seem to be an excessive pressure to apply to the seat of a ¾-in. valve.

A 2-in. globe valve with a screw pitch of $^1/_7$ in. will next be considered. On the supposition that a man would grasp the handwheel with both hands and exert a pull of 50 lb. on a 12-in. radius, the problem works out thus:

$$W = \frac{2 \times 3.1416 \times 12 \times 50}{\frac{1}{7}} \times 0.16 =$$

4222 *lb.*

This may be enough to spring a valve body out of shape. Then the only remedy is to regrind the valve.

A short time ago I saw a boiler-room attendant take a 36-in. iron bar, insert it into the handwheel of an 8-in. boiler stop valve to screw it down "tight" so it would not leak steam. He must have pulled at least 200 lb. on that bar, for he was a strong fellow. Here is what he was doing to the valve, which had a screw pitch of ¼ in.:

$$W = \frac{2 \times 3.1416 \times 36 \times 200}{\frac{1}{4}} \times 0.25 =$$

45,239 *lb.*

and this was not the total pressure on the valve seat. The disk had an area of about 50 sq.in., with 135 lb. per square inch steam pressure upon it as well, which made 6750 lb. more, or a total of 51,989 lb. Dividing by 50 would give a pressure of a little over 1000 lb. per square inch. It may be noticed that in this problem an efficiency of 25 per cent. was used, and for this case the efficiency taken is considered a conservative estimate.

The condition of the screw and its lubrication will influence the results obtained in actual practice, but these three problems will give a general idea of the treatment forced upon thousands of valves every day in the year, and yet the valves themselves are blamed because they do not hold steam or water.

If a valve does not close tight with reasonable pressure, there is no occasion for trying one's strength upon it. Such treatment is apt to ruin the valve. A careful examination will generally show the trouble and a way to remedy it, namely, grinding in or reseating.

# Electrical Department

**Conducted to be of service to the men in charge of electrical equipment in the power house**

## Small Direct-current Turbine-Generators

The accompanying illustrations indicate the practice of the Westinghouse companies in the construction of turbine-driven direct-current dynamos of 10 to 300 kw. rating. The steam end is a single-wheel impulse turbine through the blades of which the steam is passed two or more times before reaching the exhaust outlet. The dynamo is a multipolar machine with commutating poles and embodying special armature and commutator construction.

Fig. 1 shows a 100-kw. unit with the top half of the turbine casing and dynamo field magnet removed. The turbine runner overhangs one of the main bearings in this and smaller sizes, and also in the 200- and 300-kw. sizes when the turbine runs noncondensing. The wheel and blading are of the usual Westinghouse type, and embody no special features.

The dynamo field magnet is built with a split cast-iron yoke ring to the inner circle of which are bolted laminated main poles and solid steel commutating poles. When the main poles are compound-wound, the series winding encircles the shunt winding as shown in Fig. 2. This construction is so clearly shown as to render description unnecessary. Fig. 3 shows one of the commutating poles and its coil.

The armature disks are mounted directly on the shaft, but ventilating openings are stamped in the disks next to the shaft hole. These coöperate with radial ventilating ducts between disks to promote air circulation and thereby the dissipation of heat. The armature disks are clamped between bronze end-plates which are cast each with an axial flange or short barrel to support the projecting portions of the armature winding at each end of the core. This barrel or flange is heavily insulated and the coil projections are bound tightly down on it by means of steel wire.

After the coils are all in place, all openings between the wires at both ends are packed full of a fibrous material soaked in insulating compound. The projecting portions of the coils are then covered with tape, to give a mechanically smooth finish.

The high speed incidental to turbine drive makes it imperative to take special precautions for maintaining the structural integrity of the commutator. Reference to Fig. 1 will show that three rings of approximately square cross-section encircle the commutator barrel, one at each end and one around the center. These are of steel, shrunk on over mica strips, the latter being necessary to prevent short-circuiting the commutator bars. In larger sizes four rings are provided.

At the extreme outer end of the commutator, beyond the shrink ring, may be seen a series of radial vanes resembling fan blades; these are heat-dissipating blades of copper, set into the ends of the commutator bars. The tips of the blades are cooled by their motion through air, and heat therefore flows to them from the commutator bars and is thrown off. Shields are provided which protect attendants from contact with the blades, but these are not closed in against air circulation.

The commutator is built up of hard-drawn copper bars, as usual, with the mica between bars cut down slightly below the surface of the copper. The lugs

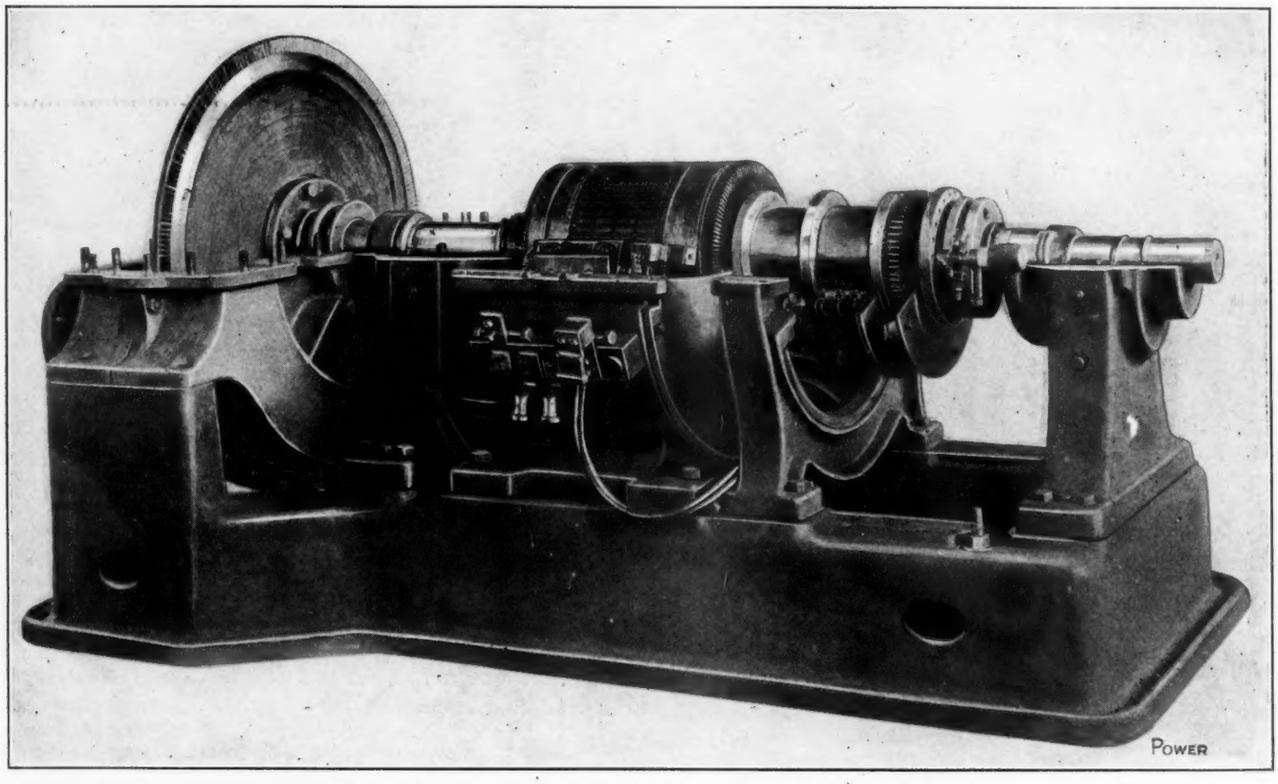



FIG. 1. DIRECT-CURRENT TURBINE-GENERATOR UNIT OF 100 KW.

or connectors between the commutator bars and the winding are of soft copper having greater current-carrying capacity than the bars. "Le Carbone" graphite brushes are used.

The unit here illustrated was built for supplying a three-wire system balanced by an external autotransformer. For

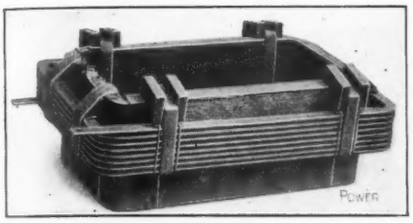


FIG. 2. MAIN MAGNET COILS

connecting the latter to the armature winding, slip rings and brushes are provided, which may be seen next to the inner end of the journal housing at the commutator end, in Fig. 1.

The machine here illustrated runs at

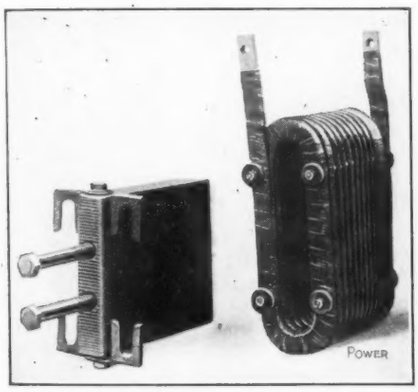


FIG. 3. INTERPOLE AND COIL

2400 r.p.m. The diameter of the turbine runner is 3 ft. 4½ in.; that of the armature is 16 in., and the commutator barrel is 8½ in. in diameter. From these dimensions, the peripheral velocities figure out at 25,450 ft. per minute for the runner, 10,000 ft. for the armature and 5340 ft. for the commutator.

## Mr. Insull on Concentrated Power Generation

In an address delivered before the American Institute of Electrical Engineers, on Apr. 5, Samuel Insull, president of the Chicago Edison Co., expressed the opinion that great economies might be effected if railways of all classes would purchase their power from central lighting and power stations instead of building and operating their own power houses.

The amount of energy required to operate the terminal and suburban systems of all the trunk lines centering in or near New York City, Mr. Insull stated, is less than the aggregate energy required to operate the isolated electric-lighting plants in the same territory. It is not a serious proposition, he said; that load is of less consequence to the properly operated electricity-supply company than the isolated-plant business was to the electric light and power companies through the country 20 years ago, or even 10 years ago.

The problem of the relation of the central station to the generation and primary distribution of energy, so far as the steam railroads are concerned, is a question of economics. It cannot properly be considered without taking into account the entire question of generation and primary distribution for any given center of population. If you consider steam-railroad electrification by itself, the amount of energy required seems to be very great indeed. If you consider it merely as an incident of the supply of energy required by a community for all kinds of purposes, it is found to be simply an incident.

The concentration of the production of energy for all purposes required in a given area of population would result in such a saving in capital, and such a saving in operating expenses, as to sufficiently provide for the generating capacity and primary transmission systems necessary to electrify the terminal systems and suburban service of all the trunk lines centering in and around any large center of population, particularly New York, and yield very large profits to the engineers and financiers having the courage to handle so great a problem.

The percentage of saving, he said, is comparatively small. On a percentage basis, the possible saving in Greater New York, including that part of the Jersey shore that would naturally be associated with New York, is comparatively small and somewhat disappointing, owing to peculiar local conditions, but it would amount to a return on such a vast sum of money that he could not see how it was possible, whatever might be the jealousies of management and the individual interests of the financial people operating the various properties, that either the engineers or the financiers could neglect the subject.

Mr. Insull then presented a large chart showing the aggregate load curve of the New York Edison Co., the Public Service Corporation of New Jersey, the Interborough Rapid Transit Co. and the station of the Hudson tunnel system. This chart showed a maximum load of 678,000 kw., and Mr. Insull stated that if this load were all supplied from one system the "diversity" factor would reduce it to 630,000 kw. and the load factor would be 40 per cent. instead of 36.9 per cent., which it averaged for the several independently operated systems during the winter just ended.

[Mr. Insull's diversity factor was apparently the percentage of the combined maximum by which that maximum is exceeded by the present aggregate of individual maximums.]

He then presented charts showing the load curves, separately, of the New York Edison Co., the electric railway systems and the Brooklyn Edison Co. and showed that the diversity of maximum load periods was such that combination supply would reduce the maximum load by about 15 per cent., the diversity factor being 17½ per cent.

Charts showing various other load curves were also shown and analyzed in support of the argument.

Reverting to the situation in New York, he said that if the power-generating systems of the whole city and its environs were consolidated into one, the reduction in investment would amount to $18,000,000 or $20,000,000 and the operating expenses would be reduced about $1,000,000 a year.

# LETTERS

## Commutator Lubrication

Having used several different preparations on commutators for lubricating purposes and not finding anything that gave good service excepting a common light grade of machine oil applied to commutators with a piece of cloth, I would like to hear what other readers of POWER have found that gave good results.

I have used machine oil on the commutator of a direct-current generator for some time and it seems to give very good service. The brushes do not cause any trouble from sparking, neither do they show excessive wear. The commutator also keeps very smooth.

I take the brushes off about once a month and clean them up; then, while the machine is running slowly, I polish the commutator with ordinary sandpaper. This keeps both brushes and commutator in good condition.

Has anyone any suggestions?

G. ALTON BARRICK.

Kenmare, N. D.

## High Mica

Upon visiting a friend recently I found him and two assistants working over a direct-current dynamo which he said had been out of commission for five days—would not pick up its field magnetism at all. He said he had tested every connection and circuit on the machine and found them all right.

A little investigation convinced me that his trouble was due to high mica between the commutator bars, and after considerable argument I persuaded him to cut it down slightly below the surface of the bars with a narrow chisel. When this was done and the commutator smoothed up with sandpaper, the machine picked up promptly. It has been running smoothly ever since.

J. G. KOPPEL.

Montreal, Can.

# Gas Power Department

**Worth-while gas-engine and producer information treated in a way that can be of practical use**

## A Few Problems in Bituminous Suction Producer Plants

By Frank Fielden

The specifications issued by builders of suction producers show that in most cases guarantees as to fuel consumption and quality of gas are based on the use of anthracite coal of a certain size. So widespread has become the use of this class of fuel that the cost has naturally increased to such an extent as to preclude the possibility of obtaining the high plant economy of eight or nine years ago. The limited areas in which suitable anthracite can be profitably mined and sold, and the widespread distribution of bituminous coal seams throughout the world, are further strong incentives to the engineer to construct a suitable suction-type generator for the satisfactory gasification of native coals which have hitherto been useless for the purpose.

It is not too much to expect that eventually even such coal as is found to be unprofitable and unsuitable for steam raising in boilers, on account of the high percentage of ash contained, will be satisfactorily and profitably gasified in this class of gas producer. At present, makers of pressure-type gas producers of the external tar-extractor class are finding this a profitable field of exploitation, coal containing almost as much as 40 per cent. of ash being successfully and profitably gasified for the driving of gas engines. The value of such a coal for steam-raising purposes is practically nil; hence such a fuel is at present either left unmined or is dumped on to the waste heaps around pit-mouths.

As the volumetric proportion of carbon contained in anthracite coal is in excess of that of any other fuel commercially obtainable, it stands, by virtue of this quality alone, above all other coals for use in suction gas producers. The extremely low percentage of ash and volatile matter of a tarry nature contained in anthracite coal also conduces very materially to its preëminent suitability for the generation of suction gas.

Within the last seven or eight years gas coke has been used for fuel with varying success, and makers have adapted their gas plants where required to suit the different conditions imposed by this fuel. The lower specific gravity of the coke demands a generator of greater cubical capacity, while the increased percentage of ash it contains, amounting in some cases to as much as 20 per cent., as compared with 1 to 5 per cent. in anthracite, necessitates increased facilities for removing clinker and ash. The increased amount of tarry volatile matter given off by the coke requires larger scrubbers and more extensive filtering to insure the gas being clean at the engine valves.

The proportions of ash and tar in gas coke vary considerably. In some districts it may be obtained almost equal to oven coke, and in other districts it approximates bituminous coal with respect to these two qualities. Even from the same gas works the fuel often varies. Owing to insufficient carbonization the coke leaves the gas works in some instances in such a condition as to prevent actual commercial success being obtained in an ordinary anthracite type of suction plant. The writer has seen a deposit of tar, equal in bulk to a walnut, on the inlet valve of a gas engine after a 10-hour run, from gas coke in a plant containing double the amount of scrubbing apparatus necessary for anthracite. It is not surprising then that early attempts at gasifying bituminous coal in a suction plant have failed to reach a commercial standard of success.

In the classification of coals, bituminous coals come between lignites at one end of the scale and anthracite at the other. Various methods of classification have been adopted, but after an extensive system of analysis and investigation of existing methods and results, Seyler states that with coal containing over 84 per cent. of carbon the proportion of the total hydrogen obtained by analysis is the most correct index, and for coals below this percentage of carbon the basis of classification is the percentage of carbon alone.

SEYLER'S CLASSIFICATION

| | Hydrogen | Approximate Volatile Matter |
|---|---|---|
| Anthracite genus | Up to 4% | Up to 10% |
| Carbonaceous genus | 4 to 4.5% | 10 to 16% |
| Semi-bituminous genus | 4.5 to 5% | 16 to 24% |
| Bituminous genus | 5 to 5.8% | Over 24% |
| Per-bituminous genus | 5.8% and over | |

A more general classification as to volatile matter is as follows:

| | |
|---|---|
| Anthracite | Up to 8% volatile matter |
| Semi-anthracite | 8 to 10% volatile matter |
| Dry steam coal (navy) | 10 to 14% volatile matter |
| Semi-bituminous | 14 to 20% volatile matter |
| Bituminous | 20 to 40% volatile matter |

### Gasification of Bituminous Coals

When bituminous coal is fed into an ordinary anthracite suction plant the hydrocarbons are distilled by the heat given off from the incandescent fuel, and these hydrocarbons are drawn through the plant by the suction of the engine, and are deposited in the pipes, cleaning vessels, and on the gas-engine inlet and exhaust valves, and even the inside of the cylinder, resulting in a gradual choking up of the gas-supply pipe with tar and soot and the sticking of the valves and piston of the engine.

It has been thought that by altering the position of the gas outlet of the generator from near the top to near the bottom, the hydrocarbons would be all drawn through the incandescent fire and issue at the outlet as fixed gases, such a type of plant being known as down-draft as distinguished from the ordinary up-draft of the anthracite plant. The problem of successfully gasifying bituminous coal in a suction plant is very closely akin to the much older problem of the smokeless combustion of bituminous coal and the more or less successful results accomplished in the latter problem should be of considerable assistance in the solution of the former, it being clearly understood that there are other difficulties to overcome pertinent to the gas producer itself.

### Air and Steam Supply

It is common knowledge that a certain minimum amount of oxygen is necessary for the complete combustion of a certain definite amount of carbon, and in the case of bituminous coal it may be stated in general terms that the combustible constituents require a certain minimum amount of atmospheric air for the complete combustion of the carbon and lighter hydrocarbons given off during distillation and combustion.

In the case of the steam boiler, regular stoking and devices for regulating the amount of air entering the furnace, and also the particular point of air admission, have been effectual in reducing the amount of smoke passing to the chimney. Mechanical stokers have successfully demonstrated the advantage of a regular rate of feed of coal with a view to the combustion of the hydrocarbons as and when formed, and it would seem self-evident that to successfully cope with the hydrocarbons distilled from the bituminous coal in a gas producer, the coal must be fed at a regular rate, preferably mechanically, means being provided to admit and regulate the amount of air necessary for combustion

at such a point as to insure the hydrocarbons distilled from the coal being mixed with the necessary amount of air, and the whole passing together through the hottest zone with a view to the complete carbonization of the raw coal. To this end the air for carbonization should not be mixed with vapor, as this would have a cooling effect, and retard the effectual combustion of the hydrocarbons given off during distillation.

In the earlier experiments with the down-draft suction plants the air for combustion was charged with vapor in exactly the same way as now holds with the anthracite plants; but it was found that, although a sufficient heat was attained for making gas of effective and explosive power, yet the tarry volatiles and soot were deposited in the gas-supply pipes, and eventually found their way to the engine.

Since it is necessary to pass a sufficient amount of vapor through the generator in order to produce good gas without the formation of an excessive amount of clinker, and to prevent the firebrick lining being burnt away, it becomes necessary to divide the functions of the suction bituminous producer into two distinct processes.

First, the coal must be coked, and, second, the coked fuel must be fed with the necessary air and vapor to produce good gas. The latter function is already completed in most suction plants now on the market. The former function is the one to which thought and inventive skill are now being directed, and as in the commercially successful bituminous suction generator, both functions should be combined, together with means for treating satisfactorily widely divergent qualities of coal, both caking and noncaking, containing quantities of ash varying from 5 to 40 per cent., and volatile matter varying from 16 to 40 per cent., some idea of the difficulty of the problems can be formed.

The amount of vacuum at disposal for the separate functions of coking and gas making is regulated by the load on the engine which the producer supplies, and since a definite amount of air charged with vapor is necessary to keep the coked fuel in a suitable condition for gas making proper, it is reasonable to expect that the air supply for coking only should be used to the best advantage. Where large quantities of coal are fed at extended intervals into a gas producer at normal working temperature, the tarry volatiles are quickly given off during distillation, and for the major portion of the interval the fuel is in a more or less fully coked condition.

Assuming a regular constant load on the engine, then the air supply is constant also, and the amount of air drawn into the generator during the coking period is no more, but is actually less, than when the fuel is fully coked, the effect being exactly similar to that produced by irregular stoking in a steam-boiler furnace. Not only is the air supply insufficient to produce complete combustion of the tarry volatiles, but the heat of the generator is considerably reduced during the heating up of the cold mass of coal, and this reduction of heat in the generator is further accentuated by the refrigerating action of the volatilization of the coal during distillation.

The amount of heat absorbed in the volatilization of the coal is considerable, consisting not only of the sensible heat necessary to raise the temperature of the solid carbon, but also the latent heat possessed by the volatiles. In the case of highly bituminous coals this latent heat amounts to about 50 per cent. of the total heat evolved, with the result that the tarry gases pass through the generator unconsumed.

Again, since complete combustion of the volatile gases given off during distillation is only attained through the thorough and complete mixture of these gases with the necessary oxygen of the air induced by the suction of the gas engine, anything which tends to reduce the vacuum available for this air supply will of necessity reduce the possibility of the complete combustion of these volatile gases. In the case of the generator containing fully coked fuel, it can be assumed that the air supply is a maximum; whereas, on the other hand, if a large, or even moderately large, amount of bituminous coal be placed in the generator, the distillation commences immediately, and the volatile gases given off at once tend to reduce the available vacuum, with the result that less oxygen is supplied to the generator at the time when the maximum quantity is most desirable and necessary.

### Oxidation of the Fuel Elements

That an intimate diffusion with the necessary amount of oxygen is a necessity in the complete combustion of bituminous fuel has been thoroughly established in furnace practice as confirming the results of the chemical laboratory. To insure this complete diffusion of oxygen with the fixed carbon of the fuel is comparatively simple; it is, however, essential that the hydrocarbons also should be subject to a thorough diffusion with the necessary amount of oxygen in order to complete their combustion. The ignition temperature of the hydrocarbons given off from bituminous coal during distillation ranges from 1100 to 1250 deg. F., when intimately mixed with the necessary amount of oxygen; and since carburetted hydrogen requires twice the volume of air for combustion that is required for the combustion of carbon, means must be provided for supplying a sufficient amount of pure air at the point where the hydrocarbons are evolved. The ignition temperature of carbon being 1240 deg. F., all the hydrocarbons must pass through a zone of such a minimum temperature to effectually prevent the ultimate deposition of soot and tar in the gas pipes and cleaning vessels. The carbon residue remaining—in other words, the fully coked coal—is then in a suitable state for forming the necessary basis for gas production proper, it being understood that the products of primary combustion are passed through this coked fuel.

The importance of a high temperature for primary combustion shows the advisability of preventing at such a point in the evolution of the process the admission of vapor used for gas making proper, while a suitable method of supplying the air in a heated state, as by regeneration, would promote efficiency in the combustion of the hydrocarbons.

To have universal application, a suction bituminous plant should be capable of satisfactorily dealing with both free burning coal and caking coal. It is a natural question to ask what constitutes a caking coal. While there is no simple relation between coking or caking power and chemical composition, it may be stated generally that coals which are either very rich or very poor in hydrogen and oxygen do not melt or cake. The coking property is probably determined by the presence in greater or less amount of certain compounds of carbon, hydrogen and oxygen, which at high temperatures are decomposed into volatile substances and carbon, the latter serving as a cement to bind the particles of the residue together. This caking power is in some cases lost very soon after the exposure to air, on account of the rapid weathering of the coal. The caking power also varies inversely with the percentage of ash contained by the coal, so that a good caking coal has a minimum amount of ash in its composition.

### Fuel Characteristics

When caking coal is fed into the top of a generator, whether of the suction or pressure type, it is fused together by the heat, and unless means are provided by agitating or breaking up the caked masses while in the generator, the air for combustion and gas making is not equally consumed through the full area of the fire, resulting in the formation of holes and spaces, through which the air passes at an accelerated rate and produces intense local temperatures, with a corresponding variation in the quality of gas produced.

Although coal loses one-tenth its weight in coking, it increases its volume by one-third. The effect of this is that when fed from the top of the generator arching over of the fuel occurs, particularly in those generators where the inner diameter gradually diminishes, and it has been observed also in generators with parallel walls, the fuel near the bottom

of the generator being almost entirely consumed, and the combustion zone gradually working upward, leaving a hollow space below the arch thus formed. The writer has seen this occur in plants using anthracite coal as fuel. With caking coal, however, the trouble is greatly exaggerated; the fusing of the coal together completes the effect of the natural expansion through heat, and any additional weight from above due to adding more fuel increases the thrust on the sides of the generator exerted by the arch.

In most cases this arching over of the caking coal is prevented by regular hand poking from above; but one or two patents have been granted for mechanically worked pokers, which, projecting into the fuel bed, are given a constant agitating motion. In one American patent means are provided for continuously revolving one section of the generator with a view to prevent the adhesion of the fuel to the interior of the firebrick lining. Other methods of overcoming this caking trouble consist in treating small portions of coal at a time, with a view to supplying each portion with the requisite amount of air, and also affording facilities for the natural expansion and caking before the fuel is fed into the main body of the generator. Thus eventually the coal reaches the main column of fuel in the generator in a fully coked condition. As a satisfactory means of dealing with either the caking property of coal or the successful combustion of the hydrocarbons given off by any bituminous coal, such a method—that is, the separate treatment of each portion of fuel previous to being passed into the main fuel bed—would seem to contain the elements of success.

### Tar and Ash Difficulties

It has been suggested by some engineers that the tar from bituminous coal should be extracted from the gas at some point between the generator and the engine, as is accomplished in pressure-type plants by means of extensive condensers, scrubbers, and tar extractors, mechanically operated and otherwise. As the reasons for the existence of the suction plant are its simplicity and the minimum amount of attendance and skilled supervision required, together with the small amount of space occupied, such a solution can be hardly expected to have universal application. A number of plants are, however, working on this system, but it is extremely difficult to find a profitable market for the tar thus extracted, owing to the impurities it contains; and as municipal authorities object very naturally to its being run into the sewers, its disposal is a matter of some moment, particularly in towns and cities. Certainly for ship propulsion such a method would be prohibitive, since the question as to space occupied is a very vital factor in these days of the steam turbine and the more recent Diesel oil engine.

Another trouble which has been experienced by the makers of suction gas plants for anthracite and coke fuel—ash and clinker—is intensified considerably with bituminous coal. Most suction gas plant attendants have experienced annoying stoppages of the engine at one time or another through the opening of doors in the generator during the clinkering and clearing of the ash from the fire in solid-bottom generators, the reason for such stoppages being that while the ash door was opened the vacuum was insufficient to induce the necessary amount of vapor required for the generation of good, rich gas to drive the engine on load. Indeed to such an extent has this possibility of stoppage been prevalent that some makers have advocated and installed twin generators for services demanding extended running periods.

With three or fourfold increase in the amount of ash as obtains in bituminous coal, then, it becomes absolutely essential that means shall be provided for removing such ash and clinker without causing an undue effect on the engine. The composition of the ash as it exists in the raw coal varies considerably, and its behavior inside the generator is no less variable, depending largely on the temperature to which it is subject.

If the temperature of the generator is kept fairly low, then the formation of clinker is a minimum, but to get good, rich gas it is necessary to work at a fairly high temperature—say, at 2000 deg. F., and at this temperature a considerable amount of the ash is fused and forms clinker. In some cases this is of a highly vitreous nature, having an affinity for the firebrick lining and being extremely difficult to remove without breaking away portions of the brickwork to which it clings. Unless it is removed periodically, it causes arching over of the fuel similar to the action of caking coal, and poor gas is the inevitable result.

It is imperative, then, that with coal of a high ash percentage every facility should be provided for the thorough searching of the generator and the effectual removal periodically of the ash, where anything like continuous running is required. In most anthracite plants the poking of the fire and clinker has to be done radially from a door or doors in the side of the generator shell, near the bottom, but when clinker is adhering to the brickwork it is next to impossible to remove it without damaging the firebrick lining.

The position of the vaporizer in most suction plants is at or near the top of the generator, making difficult the best arrangement of poking the fire, namely, in a direction parallel to the wall of the generator. In one or two generators poke-holes are found in or adjacent to the fuel hopper, but even in this case the poker must point at an angle to the brickwork, although the angle is considerably smaller than in the case of radial poking near the bottom. To anyone, however, who has had the running of a suction gas generator on full load with a depth of, say, 5 ft. of fuel, the great advantage of being able to push the poker through the fire parallel to the firebrick lining and close up to the brickwork is at once apparent.

Anthracite plants of fairly large units, say of 200 brake horsepower and upward, are fitted with a water-luted ash tube, by means of which the ash and clinker after being poked down can be removed without seriously interfering with the quality of the gas produced. Since there is in most common slack steam coal a much higher percentage of ash than in anthracite, a similar means of removing the ash and clinker will be necessary for even smaller units than those mentioned, unless recourse is made to other means, such as mechanically operated slicers similar to those now made for pressure producers gasifying coal high in ash.

There are, of course, a large number of other combustibles which may be satisfactorily gasified in suction gas plants, from dried barnyard refuse up to charcoal, including a number of more or less waste products, such as sawdust, etc., but as these have only a limited sphere of distribution the greatest desideratum is a suction gas plant which will produce gas commercially successfully from a wide and extremely variable class of bituminous coal.

To summarize, then, the ideal suction plant will consume all the volatile matter contained in the coal in addition to the solid carbon, and to effect this requires an intimate mixture of air with each portion of the coal at a suitable temperature, to fulfill which duty some means of mechanical feeding of the fuel at a regular rate to suit the load on the engine would seem desirable.

Caking coal will be so treated as to prevent arching over and consequent obstruction to an equable air and vapor supply in the main fuel column of the generator.

Suitable facilities for the effectual removal of ash and clinker formed, without interfering with the quality of gas produced, will have to be provided for coal with a high percentage of ash, and, in fact, for all coal used on extended periods of running.

The amount of space occupied, simplicity of construction, with minimum amount of attention and reasonable first cost, are factors the stating of which, perhaps, savors of triteness.—*Engineering*, London.

# Heating and Ventilation

**Considered as power-plant problems. Layout and operation of systems and apparatus**

## Hot Water Heating for the Central Station*

By Ira N. Evans†

In an article published Sept. 12, 1911, the subject of the arrangement of heaters and pumps, etc., as well as the economies of hot-water heating were discussed. This applies to central-station heating for cities and towns as well as to the requirements of large institutions and manufacturing plants.

Many central-station companies where condensing conditions are favorable, have refused to consider heating on account of the possible interference with the economical operation of the engines for power; therefore central heating has to a certain extent been limited to noncondensing plants that were paying small returns or no dividends at all. The fact that the hot-water system can be operated successfully and economically in connection with condensing engines and turbines should broaden the field. The application of hot-water heating enables the exhaust steam from a large turbine to be utilized under partial vacuum without interfering appreciably with the economical operation of the plant for electric-power purposes.

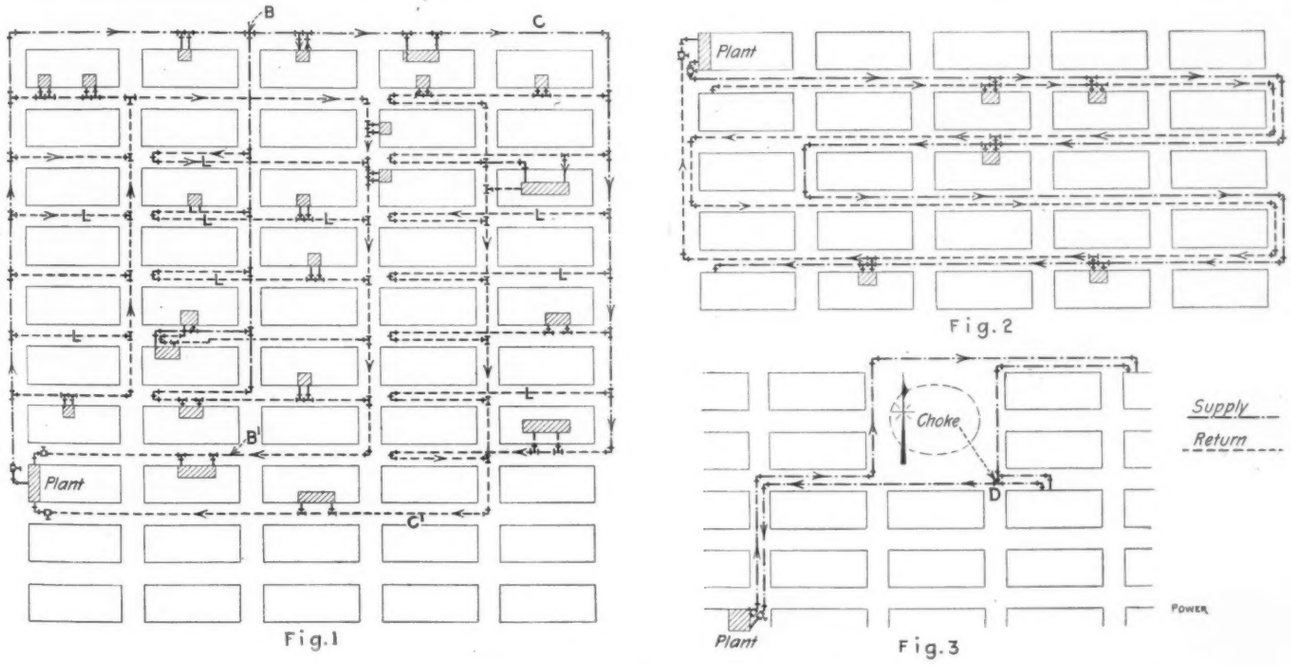
In the case of large institutions and private plants the heating has to be provided and paid for by the institution or corporation itself, and it is a question simply of what is the most economical system both as to first cost and operation and no dividends are required. In commercial town heating the conditions are entirely different. These installations are made generally in connection with an existing electric-lighting station and the heating plant is required to pay a reasonable return on the investment. The companies are not obligated to enter the heating business unless an increase in net revenue on the entire plant is assured. Besides, the customers have to be attracted by a rate low enough to compete with the cost of heating by domestic coal.

It is very necessary to operate a heating plant in connection with the power load of an electric plant so as to arrange to use the exhaust steam and eliminate the boiler investment as far as the heating system is concerned.

In cases where the margin between the cost of domestic and steam coal is large, the heating plant might pay by itself and even then the power load would greatly increase the revenue.

Many promoters have advocated the installation of heating plants, stating that there was money in live-steam operation. Neither heating nor power should be considered as a byproduct. The heating plant should be made to stand alone and pay a reasonable return on the investment. The heating cannot be accomplished unless some economy is sacrificed on the power end. All excess steam utilized for heating over what is required for power under the most economical conditions is a charge against the heating plant as well as the interest, depreciation, maintenance of heaters, mains, etc., and the space occupied by the heating plant in the boiler and engine rooms.

In a temperate climate there are only seven months when revenue can be obtained for heating, while the interest charge covers the entire year. The first consideration is the price of domestic coal and its heat value as compared with the price paid for the coal used in the central plant, as this will indicate what charge may be made for heating dwellings. The power load on the plant, its duration and amount are also to be considered. Heating, if sold commercially, is required 24 hr. per day. The ordinary electric-lighting plant has a widely fluctuating load and is sometimes




Methods of Arranging Street Mains

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inoperative Sundays and at times during week days; at such times live steam has to be used for heating.

It is a great advantage to be able to furnish both heat and power from the same plant and many customers can be obtained at fair rates. If the heating were not furnished, isolated plants would be operated in many instances, and the power load would not be obtainable for the central station.

In the consideration of the best system to adopt in any individual case the following requirements should be fulfilled:

1. The system should be flexible, with as wide a range of temperature of the heating medium as possible to meet the varying outside weather conditions. This will enable the system to be operated on the minimum average temperature and steam consumption, without depending on customers to shut off the heating surface, thus eliminating waste by overheating. This is especially important when live steam has to be used during periods of light power loads. The water system can be absolutely controlled at the plant and a given amount of exhaust steam can be made to cover a greater territory due to the average lower temperature of the heating medium than when steam is used directly in the system. From a previous issue a table is given showing that the extreme weather in temperate climates only occurs about 25 per cent. of the heating season. The steam per hour required for the remaining 75 per cent. of the time, or average weather, is only 60 per cent. of what would be required in zero weather. Where steam is utilized at 212 deg. and a constant pressure, and the radiation is not automatically controlled, the steam consumption does not vary more than 15 per cent. between the maximum and minimum temperature outside during the heating season. The hot-water system shows a variation in steam requirements of 100 per cent. between the minimum and maximum outside weather requirements, and a change in the temperature of the hot-water system may be readily effected as the outside temperature varies.

2. The system should be so capable of arrangement as to absorb the heat from any source with economy, and in the case of the use of exhaust steam with a minimum increase in steam consumption for power and the least interference with the operation of the engines over summer conditions, when no heating is required.

3. The capacity should be ample to do the heating at all times without excessive temperature of the medium, and admit of arrangement so that different sections can be independently controlled at the power house within reasonable limits.

4. There should be a minimum loss in transmission and the system should be independent of grades as regards circulation.

5. The power of circulation should be independent of the temperature of the medium; that is, it should be capable of maintaining the same rapidity of circulation with the medium at any temperature. It should not be necessary to lower the temperature and pressure of the medium at the end of the line merely to produce more rapid circulation.

6. The probable repairs and cost of maintenance should be low.

7. The cost of the different systems should be compared as well as the probable operating expense; any excess in expenditure in first cost of one system over another should show at least 10 per cent. gross saving of that amount as an offset.

8. The number of kilowatts obtained per pound of exhaust steam when utilized on the heating system for different outside temperatures should be determined. A heating system might be economical in the use of steam, as far as the radiation is concerned, and the increase in steam consumption on the engine units due to the manner of utilizing the exhaust on the heating apparatus be excessive.

In the case of small plants where the distances are comparatively short and all existing installations steam, it might be inadvisable to use a water system. It is comparatively inexpensive to change a first-class low-pressure steam system to hot-water unless steam radiators without top connections are used, in which case the radiators have to be replaced. Where hot-water radiators or coils are already installed, the only requisite is the enlargement of the return pipes, and in the case of a single-pipe steam job the addition of the return connection to the radiators from the riser.

It will be found in practice where exhaust steam is to be used under very low pressures that considerable expense will have to be incurred to adapt existing steam systems of customers to operate successfully from a central plant. One installation with poor circulation may cause an excessive back pressure on the engines and make the entire system more uneconomical, due to the increased pressure and temperature of the steam.

In many cases the wasting of the condensation is considered more economical than the maintenance of an expensive system of return mains with attendant traps, pumps, etc.

Where the grades are favorable, so as to eliminate pumps or traps, the conditions warrant the return of the condensation by gravity, but they are seldom met in practice. These conditions are eliminated entirely on the hot-water system, as no steam is taken outside of the plant. The exhaust steam is utilized under partial vacuum between the engine and condenser in an exhaust-steam heater. The heating system is utilized as a condenser to the extent of its capacity at any time, reducing the load on the regular condenser by that amount. All units not required to furnish exhaust steam are turned into the condenser under full vacuum.

It has been found by experiment that, with a given amount of radiation on a heating system, the steam requirements in temperature and amount will exactly balance a given constant load on a turbine by simply changing the vacuum to suit the outside weather conditions according to a prearranged schedule. That is, with 70,000 sq.ft. of direct radiation on a town heating plant and 400 kw. load on a turbine, the exhaust steam under vacuums from 0 to 28 in. will exactly balance the heating requirements between 0 and 60 deg. outside temperature. The same power load may be carried on the turbine throughout the entire heating season, the heating system acting as a condenser and reducing the steam rate per kilowatt-hour as the vacuum is increased. All live steam may be utilized under boiler pressure in a separate live-steam heater, the condensation being returned by gravity to the boilers. The pumps should be of the turbine type, of sufficient capacity to keep the maximum drop in temperature of the water in the system below 20 deg.

If the radiation were increased 10 per cent. over the requirements of a low-pressure steam or vacuum system, the lowest vacuum in extreme weather would not be below 4 or 5 in. and with two pumps in series the turbine would never have to be operated on no vacuum or back pressure above atmosphere. Where a steam-heating system is considered in connection with a turbine installation, the 100 per cent. increase in steam consumption for power due to the total loss of vacuum at all times may be fatal to its financial success.

There is a mistaken notion that a pump alone on the end of a steam line will produce a vacuum. This is not true unless the steam is actually condensed. If the heating apparatus has not sufficient condensing capacity, cold water has to be added to increase the cooling effect. This water is allowed to overflow and is wasted unless make-up water is needed for feed purposes.

One of the first requisites for a proper vacuum system is a thermostatic or float trap or check valve introduced between the steam in the system and the vacuum in the return so that bypassing will be prevented and steam will not enter the return system. The vacuum on any heating system is therefore limited to the degree to which the piping system can be made air-tight, and by the condensing capacity of the heating surface at any time. When extensions are required on a steam system which is loaded to its capacity, a new line

of larger pipe has to be installed or the pressure has to be raised on the existing line. Increasing the initial pressure on the line raises the back pressure and corresponding temperature of the heating steam on the near-by radiation, causing extra expense in addition to that involved by adding the new heating surface.

It may be readily seen that 1000 sq.ft. of heating surface 2000 ft. away on a steam system will require a larger main or greater pressure than the same radiation 200 ft. distant from the source. The extra distance on a hot-water plant does affect the pumping capacity, requiring greater power, but does not affect the vacuum or back pressure under which the engine units are operating.

The question of back pressure and size of main practically limits the distance covered on a steam system with economy, while the only limiting condition on a hot-water system is the cost of mains against another plant nearer by. A vacuum produced on the end of a steam line would increase the velocity, but at the same time the volumes of steam at low pressures increase very rapidly, offsetting the advantages and increasing the size of mains for a given output. There are 26.8 cu.ft. of steam per pound at atmospheric pressure or 212 deg., and 19.4 cu.ft. per pound at 5 lb. pressure above atmosphere and 230 deg. temperature. Forty per cent. more area would be required at atmospheric pressure for the same output and drop in pressure than would be required for 5 lb. pressure; also 12 per cent. more heat would be radiated by the heating surface at the higher steam temperature and pressure.

The mains of a steam system radiate the heat at a temperature of at least 212 deg., while that of the water system varies from 100 to 200 deg., averaging about 40 deg. less, depending, of course, upon the installation. The removal of condensation from the steam mains through traps is necessary to prevent water-hammer and involves considerable loss that does not occur with the water system. Customers do not have to bother with valves or air valves on the radiators and the disagreeable odor of cylinder oil so much in evidence when exhaust steam is used directly in the system is eliminated. The snapping and cracking of pipes so familiar to all is absent and also keeps the repair bill of the water system low. To make a central heating plant successful, every corner must be guarded, and frequently it is the small economies that place the plant on a profitable basis.

A hot-water system may be extended by adding mains, heaters or pumps without abandoning existing apparatus. Separate mains may be extended to new districts and the distance will not increase the size of the main on the water system in anywhere near the ratio that would be necessary in a steam system. Where a section is overloaded the circulation may be increased by a small booster pump placed in that particular circuit out on the line and operated by current from the main station. The increased velocity will carry the extra heating surface at slight expense without enlarging the mains.

The central hot-water heating plant should have recording thermometers on the supply and return mains and on the steam spaces of the heaters, as well as a recording venturi meter; with these instruments an exact record can be obtained of the output of the heating system in heat units. With an exact knowledge of the cost, a flat rate per square foot of heating surface per season can be charged, which is more satisfactory than meters or other devices.

All heating surface should be so carefully proportioned that a few radiators will not require that the whole system be operated on higher water temperatures. All pipes and connections in the power house should be arranged so as to make it easy and convenient to change the vacuum and water temperatures or the economy will suffer. A careful schedule of operation and a recording thermometer for the outside temperature should be provided, the schedule being checked with the required temperature of typical rooms on the system at frequent intervals. The water in the system should be changed as little as possible and all leaks should be investigated and repaired at once, as an exchange of water in the system is likely to cause the piping to pit and deteriorate. The use of a cooling tower and the furnishing of domestic hot-water supply utilizing the same water is liable to cause deterioration, due to the introduction of new make-up water.

All condensing apparatus should be entirely independent of the heating system as far as water connections are concerned. Pumping against the static head of the system is bad practice, as even when the apparatus is not very high it adds just so much unnecessary head.

Placing the expansion tank in the power house is the most satisfactory arrangement, inasmuch as any change in head or loss of water in the system is immediately detected.

The central-station man considering the addition of a heating plant cannot study the situation too closely, keeping in mind the important fact that the investment must be kept as low as is consistent with good workmanship and first-class construction. Spreading promiscuously all over the town must be avoided and only just sufficient mains should be installed to utilize the available exhaust steam to the best advantage. The use of hot-water boilers should be avoided and the live-steam heater should not be eliminated by introducing the live steam into the exhaust-steam heater through a reducing valve, as this method is uneconomical in operation.

It is impossible to regulate with great accuracy the temperature of the water in the case of hot-water boilers, as the grate surface necessary to heat sufficient water in zero weather would be 40 per cent. too much when the temperature ranged between 30 and 40 deg. F. Consequently the water would be too hot or too cold, and by attempting to cut boilers in or out of the system coal is wasted. Besides, there would be an extra investment in boilers. A motor-driven pump and a steam-driven pump should be used, either capable of carrying the entire plant, with connections in series so that both can be operated in extreme weather if desired. The motor-driven pump may be operated with current from the large unit furnishing steam for heating at a cost of not over 25 lb. of steam per kilowatt-hour. The ordinary vacuum pump on a steam system requires about 150 to 160 lb. per kilowatt-hour and the exhaust from these pumps cannot be used on the heating system to the same advantage as the steam from the pump on the water system. This means that six times the power can be used for circulating the water system at the same steam consumption as would be required for a vacuum system.

It is very bad practice to regulate the temperature of the water system by varying the speed of the pump, as it simply means a higher initial temperature of the outboard water, thus reducing the amount of vacuum and reducing the power obtained from the steam used for heating.

All underground work should be installed in a thoroughly first-class manner. The mains should grade up in the direction of the flow, with proper provision for the relief of the air automatically at all high points.

If the ground is dry and the subsurface well drained, wood stave covering may be used for conduit. If the ground is wet or moist, this type of conduit will deteriorate in a very short time. Tile pipe with chairs and rolls with hub and spigot joints set with cement make the best construction. The pipes may be packed with cheap nonconducting material, and as there are no drips, traps, etc., required, the space around the pipe can be kept perfectly dry. Manholes of brick with cast-iron covers should be used at each expansion joint, anchor and house connection. Expansion joints should be placed every 200 ft. with an anchor between, of a channel or I-beam laid on its side and bricked in solidly into the brick walls of the manholes.

House connections can generally be combined with the anchors and expansion joints in the same manholes. Packed sleeve expansion joints are apt to give trouble unless the bolts are gone over frequently to take up on the packing.

When the pipe contracts, it compresses the packing, and when it expands, the joint leaks, as the packing is not sufficiently resilient. This can be overcome by using a joint with a double sleeve, one held by heavy springs which keep the packing compressed under all conditions; this joint, however, is very expensive. The wear on an expansion joint in a hot-water system is far greater than when steam is used, as the temperature of the water is varied continually with the outside weather while the temperature of the steam is fairly constant. U-bends or a break across the street and back at intervals have been used with success and this method is inexpensive.

Flanges should not be used on underground work except in manholes as provision has to be made for the movement of the pipe; good wrought-iron couplings are preferable. In many town heating plants the shunt system has been found very advantageous as it only requires a single pipe and the entire distance up to its capacity can be utilized for service connections, especially where the pipe supplies through one street and returns through another. It is sometimes customary when house connections are large to reduce the main one size between the supply and return house connection, introducing friction. This will materially reduce the size of pipes required for the house connection by increasing the velocity in the shunt. Care must be exercised, however, that the capacity of the main for the remainder of the plant is not interfered with by reducing the size of the main at too many points. Y-branches have proved of no advantage in this work and only complicate the construction. Long-turn elbows and bends and double-sweep tees are of advantage on the mains, especially where high velocities are maintained. Reducing fitting with cored outlets should be avoided due to the loss in head. Radiator connections may be made with short-turn ells as the velocities are comparatively low; extra-heavy nipples should be used in all cases on water systems, especially for small sizes.

The price of heating in most parts of the United States cannot exceed 25c. per square foot of radiation per season without prohibiting its use by customers who do not feel able to pay for the convenience.

Fig. 1 shows an arrangement of street mains which will work out very economically for a compact district, and the arrangement permits readily of future extensions. If the supply and return are installed to *B* and *B'*, the full length of the main is available for shunt connections and *C* and *C'* can be added later. The branches *L* need not be installed until customers require connections. This system gives a pipe in each street and supply and return connections can be made where a large amount of surface may be required to be added for any individual customer, reducing the size of the house main over what would be required if operated on a shunt system.

Fig. 2 shows a system with a supply and return in each street. The house connections here can be made smaller and lower velocities can be used on the main, reducing the friction head on the pump.

Fig. 3 shows a shunt circuit for a small installation where only a portion of the town is covered and some of the service is a considerable distance from the plant. A valve at *D* forces the water around the branch circuit. All house connections would be made in shunt. A smaller main would be required than for a supply and return system and a higher head would be required on the pump, due to the greater velocity. Where the exhaust steam from the circulating pump can be utilized the operating expense is less than the interest on the investment in long mains of greater diameter. Where a proper velocity is maintained on the main, a 2-in. pipe will take care of 1000 to 1200 sq.ft. of surface on a shunt circuit. All branches to buildings should be covered with sectional covering. An efficient and cheap method is to use $\frac{1}{32}$-in. asbestos paper cut in rolls 6 in. long and wrap it around the pipe spirally until there are several thicknesses.

The following data were obtained from a plant installed some time ago which has been very successful financially and was arranged similarly to the system shown in Fig. 3. This plant is run noncondensing and has a capacity of 200 hp. The engine is of the Corliss type, using about 28 lb. of steam per horsepower-hour. There are 28,000 sq.ft. of heating surface on a 5-in. circuit, all connections being in shunt. There are three 3-in. shunts off the main, which is about ¾ mile in length. A 12-hp. pump is used to circulate the water and the usual exhaust and live-steam heaters are installed. The pump maintains a difference in head on the circuit of 20 lb.

A charge of 15c. per square foot of radiation per season is charged to all customers and coal costs $1.69 per ton delivered in the boiler room. The total income from the heating plant is $4200 on 28,000 sq.ft. of surface. The amount of coal chargeable to the heating service, including Sundays, when the engines are shut down, is about 300 tons per season, which would amount to $500 and leave $3700 to cover the interest on an investment of $15,000, depreciation, etc.

The question of extending this plant came up and it was decided not to increase the plant further than there was exhaust steam from the power load to supply heat. The investment in mains and extra boilers for live steam for heating purposes, unless additional power load was available at the same time, made it inadvisable.

It is very important to obtain a day load, and in many small towns manufacturers can be induced to locate if they can obtain both power and heat from an outside plant. A considerable day load can be attracted by lowering the rate somewhat. Electric power should not be sold at a loss simply to obtain exhaust steam for heating, and the heating should not be placed below cost simply because the exhaust steam may be a byproduct. In any case, considerable live steam has to be used on periods of light power load to supplement the exhaust steam, and this charge becomes greater with the size of the system. On the plant referred to there is an average day load of 150 hp., which takes care of the heating until the weather gets below 10 deg. outside.

The buildings may be piped from a supply main looping the basement, with the first-floor radiators shunted off direct and the two upper floors supplied by separate risers. For buildings over three or four stories an overhead system is preferable, with single risers connected to the return in the basement. The radiators may be shunted off the riser from two tees 2 ft. apart. In Figs. 1 and 2 proper circulation is effected without the use of choke valves on house connections. These should be avoided and will not be required in the building mains if the piping system is designed properly.

## LETTER

### Cause of Pump Racing

I have had trouble similar to that described by Mr. Moulton in the Apr. 2 issue and I believe it is due to generation of vapor in the water cylinder of the pump during a quick reduction in pressure in the heating system. I would suggest that he reduce the steam pressure on the system very gradually when cutting it off, and in that manner keep the temperature of the water cylinder and the system more uniform; in other words, let the pump cylinder cool down with the system.

C. H. WILSON.

East Orange, N. J.

The comparative fuel cost at the Port Henry (N. Y.) power plant, according to the *Engineering and Mining Journal*, is as follows: 11 tons of No. 2 buckwheat (anthracite) worth $2.65 per ton at the plant, is equal in heating value to 10 tons of bituminous, at $3.92 per ton, or $29.15 worth of anthracite equals $39.20 worth of bituminous coal, thus making the cost of operating with bituminous 1.345 times more than for anthracite.

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# POWER

## Give Authority to the Public Service Commission

Destructive competition in public utilities is manifestly a bad thing, but in return for a franchise virtually granting a monopoly in any city, a public-service corporation should willingly submit to regulation by the proper authorities.

Hearings in the rate case against the New York Edison Co. have been dragging on before the Public Service Commission for several months and now that a new petition has been introduced (as announced by us two weeks ago) the indications are that another equally long period will be required. At the first hearing under the new petition, in answer to a request for the number of consumers in each class and the amounts received from each class during the past three years, Mr. Hemmens, counsel for the New York Edison Co., announced that the company did not intend to give out any information further than that included in its annual reports to the Public Service Commission. As is well known by anyone who has attempted to make use of these reports, they are not in such form as to permit of definite deductions.

If this is the attitude of the New York Edison Co., it would seem almost useless to proceed further with the hearings until the status of the commission, relative to its power to compel witnesses to answer pertinent questions, is determined. Repeatedly during the former hearings the commissioner ordered the witnesses to answer certain questions, whereupon counsel for the defendant instructed them not to answer. Needless to say, the witness always followed the dictation of the counsel in defiance of the commissioner, and the latter was apparently powerless to take any action.

The New York Public Service Commission for the first district alone costs the state over one million dollars annually, an amount in return for which the people have reason to expect results. If the commission is to be of real service to the state, it should be granted full powers to investigate and get at the bottom of all facts pertaining to complaints brought before it.

The good work that has been accomplished by the Wisconsin Railway Commission forms a precedent and shows what can be accomplished in the regulation of public utilities where the commission is vested with the necessary authority. Why, then, should not New York follow the excellent example set by Wisconsin?

## Competition

In the power plant, as in all nature, the struggle for existence is daily becoming more and more acute. Usually, the fittest survive and the weaker perish, the individuals who exert little progressive effort being soon relegated to insignificance.

The plants that through mismanagement are high in operating costs must sooner or later be displaced by central-station service. There is perhaps no other good reason for central-station service shutting down an isolated plant of ordinary output. Local conditions, such as close proximity to a hydro-electric station, where the cost of current generation is exceedingly low, may determine the advisability of closing down an isolated plant, but generally the properly managed isolated plant can survive the persistent competition of any central station.

Deep in the consciousness of most engineers lies the knowledge that central-station service would mean a great decrease in the operating costs of hundreds, even thousands, of power plants. Central-station men also clearly realize this, and hence the logic of their arguments in their relation to such plants. Engineers in charge of these excessively high cost plants know, or surely ought to know, that it is only a matter of time when the forcible talk of the central-station solicitor, substantiated by figures

and other data, will convince the management that its power division is a source of heavy loss and a contributory cause of low dividends.

Once convinced, the isolated plant must go because modern business cannot, and will not, tolerate a remedial loss. The engineer's only hope then is to prevent the management from becoming convinced. He must not expect to achieve this by mere emotional or persuasive argument. That day is past. Argument by conviction, which calls for worthy evidence, must be made to be effective.

To obtain such evidence means a close study of modern power-plant management, the systematizing of the operating work, and, above all, the use of records particularly adapted to each department of the plant. While this adds to the duties of the engineer, the conditions demand it, and the key to survival is in adapting the plant to the conditions.

## Unnecessary Risks

While sometimes in power-plant practice it is necessary for the continuation of service to assume grave risks, more often it is foolhardy. It should be remembered that men who assume these risks not only jeopardize their own lives and limbs, but in most cases those of others in the immediate vicinity are also endangered. The man in charge should therefore use much discretion in allowing his subordinates to do such work.

For instance, an exceedingly long-handled wrench should not be used to tighten the defective and leaky caps on water-tube boilers under high pressure. No harm will be done if all the parts are sound but too often they are defective.

The practice of assuming that the physical condition of the boiler will admit of more heavily loading the safety valve and that it and the steam gage are correct, is poor engineering; such things should be accurately ascertained, not taken for granted.

It is also unjustifiable to risk putting water into a boiler in which the attendant does not know how far below the bottom gage-cock the water has gone. Happily, this is done but infrequently. It is better in such cases to cover the fires, taking no dangerous chance just because the attendant fears being discharged, which is his only reason for assuming the risk. His life and that of others are more valuable to the community than his job. It is also wrong to send men into a hot boiler shell into which a great volume of steam is pouring through the dry-pipe, without posting someone on the outside to play cold water into the boiler and to observe and assist them if they collapse.

No meager amount of discretion should be exercised in deciding how long a serious leak on a high-pressure line of any kind should be allowed to continue before its repair. The practice of entering the ashpits under a bright fire to repair a section of the broken grate bars is also to be condemned. To work on a closed high-tension electric circuit "just to save time" is nothing short of suicidal, but it is done now and then.

All of these things are commonplace, but it is just as criminal to assume unnecessary risks in performing them as it is to allow an intoxicated man to take charge of the equipment.

Perhaps most important of all to conservative practice is to keep uptodate and be at all times conscious that operating engineers are in charge of the basic thing upon which all modern industry depends for its existence and continuity—power.

## Commendable Loyalty

Disregard for the peculiarities of human nature is often responsible for the complete failure of ideas that might otherwise have proved productive of good results, as the following case well illustrates.

The plant is one of the largest in the East, its management, all things considered, is admirable, and the chief engineer is thoroughly competent as the success of his department attests.

As the manager desired more coöperation on the part of the men, he requested that if any of the employees had ideas which they thought would improve the plant's operation, he wished that they would report them to him. No mention was made of the chief engineer.

One by one the men read the notice, smiled, and walked away. The manager did not receive one reply to his request, and perhaps he is still wondering why. The only comment of the men was that they would not ignore their superior, the chief, by carrying their suggestions beyond him to the manager. With this type of men much can be accomplished if they are properly handled.

## The Smoke Inspector in Trouble

The labor difficulties in the coal fields both here and abroad have made the smoke inspector's task, which at no time is a sinecure, particularly arduous. The strike in England has led to the exportation of practically all the better-grade coal mined in the vicinity of the seaboard. Because of the threatened trouble here the balance of such coal has been bought either by the railroads or by the large consumers and as a result none can be secured in the open market.

This makes it necessary to burn low-grade fuel in a large number of plants not suitably equipped. The consequence is much smoke which the inspector is helpless to prevent, for it would be unreasonable to require a change of equipment because of this temporary condition of the market. On the other hand, the general public, entirely ignorant or thoughtless of the underlying cause, rails at the dirty condition of the city's atmosphere and unjustly condemns the smoke inspector as incompetent or worse.

## Returns to Engineering

Cecil P. Poole, for the past seven years junior editor-in-chief of POWER, has resigned that position in order to engage in consulting engineering. He will enter into partnership on May 1 with Lamar Lyndon, of New York, and the headquarters of the new firm will be located at Atlanta, Ga. Mr. Lyndon's New York office will be continued as heretofore and will coöperate with the Atlanta office, which will be conducted by Mr. Poole.

During the past 12 years Mr. Poole has specialized in the design and construction of electrical machinery and in gas-power engineering in general, and the information and experience accumulated during that period should be of much value to him in the line of work he is now entering.

He carries with him the best wishes of POWER, and of the members of the staff with whom he has been so pleasantly associated, for an abundant success in his new field.

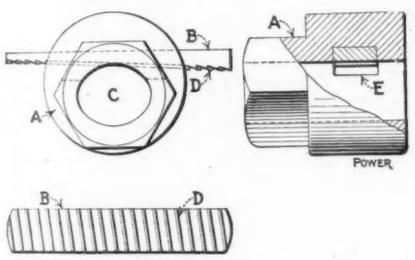
# Readers with Something to Say

**A letter good enough to print will be paid for. Ideas, not mere words, wanted**

## Stud Extractor

The accompanying illustration shows a home-made stud extractor and driver. This device will be valuable to any power plant.

In the illustration, *A* is a bushing nut,




STUD EXTRACTOR

*B* is a wedge, *C* is an oval hole, and *D* are teeth on the wedge to prevent slippage between the stud and the wedge.

With this extractor three sizes of studs may be extracted or driven with one wedge.

J. G. KOPPEL.

Montreal, Can.

## Steam Consumption of Compound Pump

An engineer asked me why a duplex compound pump took more steam when running with the cross exhaust open than when running with it closed. I replied that I did not know that it did.

He then stated that when running a large elevator pump, and the boilers fired with gas, he found that when the gage indicated 100 lb. pressure with the cross exhaust of the pump open, the steam pressure would increase to the blowing-off point if the cross exhaust were closed. This had been tried over and over again, and he got the same result each time.

I determined to find out if this were so and went over and had a look at the old 10, 16 and 10 by 10 pump that I had been running for years. I knew that when I closed the valve in the cross exhaust the pump made a shorter stroke than when the valve was opened. I had been told to run with the valve one-quarter open and I had done so without thinking of the reason why, just as we often do. As the cylinders were tapped for the indicator, I proceeded to investigate. Diagrams were taken from the high-pressure cylinder, but they shed no light on the subject, but on shifting the indicator to the low-pressure cylinder the reason for greater steam consumption was apparent.

The diagram taken with the cross exhaust closed is shown in Fig. 1; that with the exhaust valve open is shown in Fig. 2.

With the valve closed the low-pressure cylinder gets steam only from the high-pressure cylinder on that side, but with the valve open it got more steam from the other side, when near the end of the stroke. This produced a longer piston stroke, due to the higher pressure, and a higher exhaust pressure when the exhaust port was opened to the atmosphere; consequently a higher steam consumption.

E. J. SAXE.

Christopher, Ill.

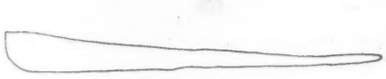


FIG. 1. VALVE CLOSED

FIG. 2. VALVE OPEN

## Why Two Engineers Did Not Get the Positions

In a certain town of about 5000 people the lighting plant employed three engineers. The chief had the shift from 7 a.m. until 5 p.m., and did his own firing, but the load was light and he had plenty of time for the other work.

The company paid good wages but the manager did not believe that paying a $75 man $100 would make a $100 man of him.

The manager was looking for the latter priced man, but had the place temporarily filled by an $85 man. On one occasion this man was ill and an ice-plant engineer was secured, his plant being temporarily shut down. He came highly recommended and the manager was glad of an opportunity to learn more of his ability.

It was customary to weight the coal used and report the quantity consumed during each six-hour period. The coal was unloaded from the cars and piled near the boiler house and each engineer wheeled his own coal. The manager required the engineers to always use from the oldest pile, and by unloading each new car of coal on a separate pile the manager was able to check the engineer's weights against the mine weights, and also tell within a ton the amount of coal on hand.

The ice-plant engineer, although knowing of this rule, used from the new carload while there was still some left on the old pile, because the former was nearer and he was not going to wheel coal any farther than he had to for anybody.

There was another engineer in this town who had asked the manager for a position and his application was put on file. In the meantime this man obtained a position that would only last a few months, running a new engine.

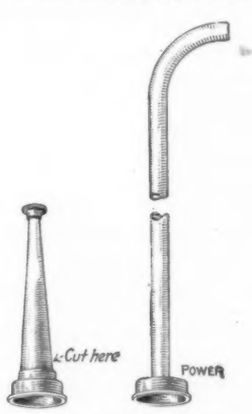
Shortly after this, two vacancies occurred at the light plant. Remembering the incident of the coal pile, the manager promptly turned down the ice-plant engineer's application for the position of chief engineer, and on visiting the other engineer he found the new engine covered with dirt and the floor wet with oil. Other men got the positions, and no wonder.

G. E. MILES.

La Jara, Colo.

## Boiler Washing Tool

An old hose nozzle cut off near the big end and tapped out for a ⅜-in. pipe, which can be supplied of a suitable length to fit the conditions, makes one of the handiest tools for washing return-tubular boilers.




BOILER WASHING TOOL

I use one with the end of the pipe bent to an angle of 90 deg., as shown in the illustration, and can reach almost any part of the boiler.

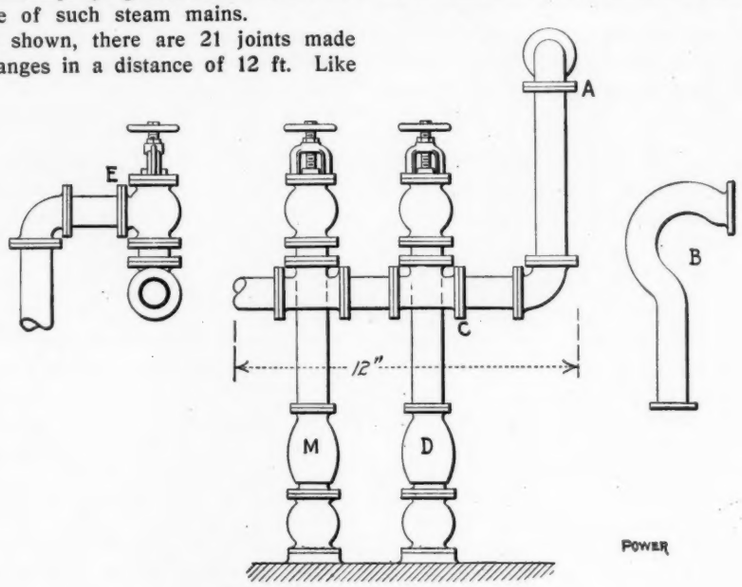
A. G. KNIGHT.

Omaha, Neb.

## Eliminating Joints

The arrangement of steam piping in many power plants leads to the belief that the engineer or someone connected with its general plan has some interest in the manufacture and sale of fittings. The accompanying illustration is an example of such steam mains.

As shown, there are 21 joints made by flanges in a distance of 12 ft. Like




SHOWING SUPERFLUOUS JOINTS

many lines, the covering is only put on the steam pipe, the uncovered flanges acting as a "radiator." Many of the joints could be omitted and a special bend could be made as shown at *B*, which could reach from the point *E* to points *M* and *D*. The same could be done from the flange *A* to *C*.

C. R. MCGAHEY.

Baltimore, Md.

## Costly Negligence

My experience may serve to illustrate the importance of a thorough inspection of the interior of boilers before they are closed up and put into service after undergoing cleaning or repairs.

I had been in charge of this plant only a few days when I saw, in the furnace of a return-tubular boiler, a bag about 2 ft. from the girth seam in the front fire sheet. The boiler was taken off the line as soon as another boiler could be connected. The next day, on entering the damaged boiler I was surprised to find a burst sack of sand lying across the tubes about one-fourth the distance from the front head.

The circulation had scattered it more or less, but there was a fair-sized pile over and surrounding the place where the bagging had occurred. The bag was so bad that I had the piece cut out and a hard patch put on rather than try to hammer it up.

ROBERT TOMLINSON.

Chicago, Ill.

## Cutting and Applying Gaskets

In applying a gasket to a flanged joint, I find it better to cut the gasket to fit inside of the bolt-holes when possible. This will give a better chance to draw the flanges together and the gasket will not be as liable to injury, caused by the cutting of bolt-holes, which are hard to get exactly in line with the holes in the flange. If the holes are not in line, the gasket will be strained in places, causing weakness.

One should always be very careful to use as thin a gasket as possible; it will give less chance for the action of steam or water on the joint.

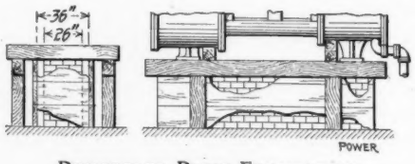
When a joint is to be broken often, one should apply a mixture of graphite and cylinder oil to the one side of the joint to keep the gasket from sticking to both surfaces.

J. ALTON BARRICK.

Kenmare, N. D.

## Pump Foundation

In one plant a new service pump was installed, as the old one was too small to supply the increased needs. When the new pump arrived measurements were




REMODELED PUMP FOUNDATION

taken for the proper fittings; then the old pump was removed and the new one was placed on timbers ready for it, as shown in the side and end elevations.

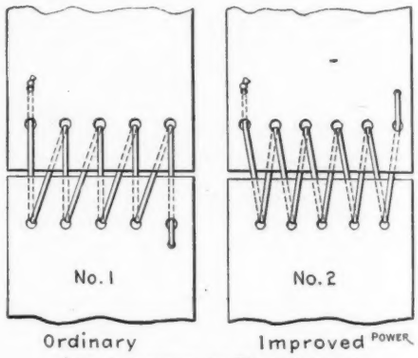
The old foundation was left standing and a wooden form was built around it large enough to accommodate the new foundation for the larger pump; then the anchor bolts were placed in position and the form surrounding the old foundation was filled with concrete. After the concrete had set, the timbers and form were removed and the foundation was smoothed off with a trowel and mortar to give it a finished appearance.

JAMES G. SHERIDAN.

Brooklyn, N. Y.

## Eliminating Belt Troubles

Having experienced much trouble with belts laced as shown in No. 1, a relief was sought by lacing all belts as shown in No. 2.




ARRANGEMENT OF BELT LACING

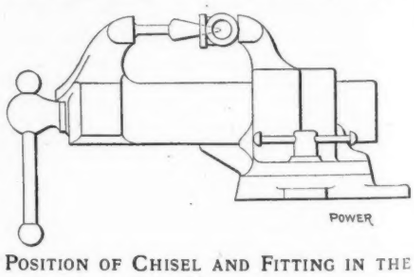
When laced as in No. 1, the lace holes in the belt persisted in tearing out, especially on the left side. When the improved method was tried this trouble ceased.

HARRY D. EVERETT.

Fort Apache, Ariz.

## Removing Broken Pipe Ends

The removal of broken pipe ends from fittings, which is usually a troublesome job, is made quite easy by driving a cape-chisel into the broken end, but in-




POSITION OF CHISEL AND FITTING IN THE VISE

stead of placing the fitting in the vise, the point of the chisel is so placed and the fitting is turned.

With fittings where the point of the chisel cannot be grasped, the vise should be opened wide enough to have one jaw press against the head of the chisel and the other jaw against the fitting, as shown in the illustration. I have used both methods with excellent results.

A. T. KASLEY.

Swissvale, Penn.

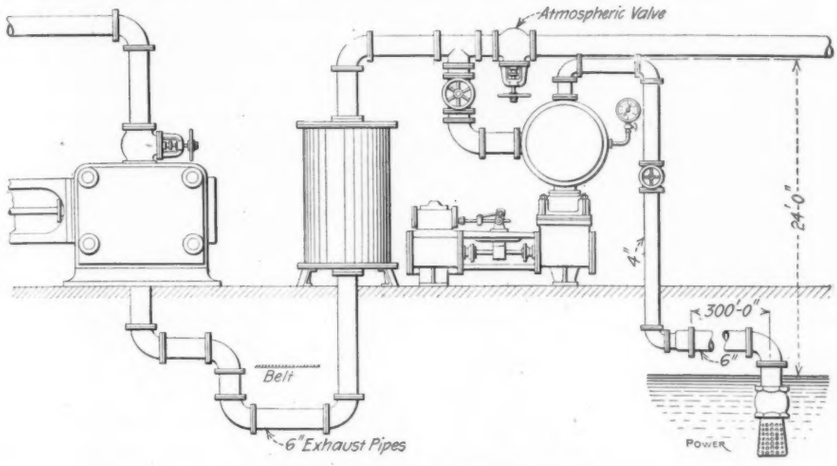
## Troublesome Condenser

The accompanying illustration shows a condenser and engine in an electric-light plant. The condenser was recently installed but it fails to work; it will not hold the vacuum when the engine is running and will only pull 24 in. with the engine cut off from the condenser.

It is 300 ft. from the condenser to the lake, and the lift is 24 ft. There is no automatic relief valve to the atmosphere, just a common disk valve. What would be the result if the condenser should lose its vacuum while the engine was running? I would like to hear from POWER readers on this subject.

B. A. JACOBS.

Frankfort, Mich.

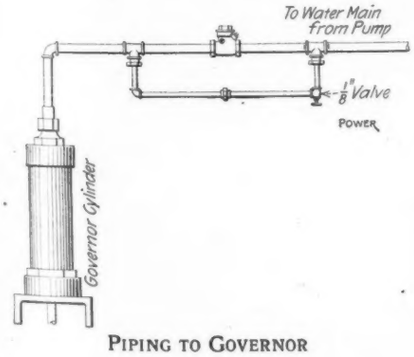



ARRANGEMENT OF CONDENSER PIPING

## Pump Governor Trouble

A duplex pump, with a suction pipe 125 ft. long, gave a very uneven discharge which seriously affected the operation of the throttling governor.

To overcome the trouble the governor connections to the discharge were changed to the arrangement shown in the illustration. The water then had a free passage to the governor cylinder through the check valve, but in returning it must pass through the ⅛-in. line and angle valve. By adjusting the valve the governor can be made to operate without excessive fluctuation, and the pump can be run steadily and without noise.




PIPING TO GOVERNOR

H. L. BURNS.

Mayville, N. D.

## Loose Locknut Causes Wreck

The piston rod screwing out of the crosshead caused the piston to butt out the cylinder head and break a piece out of the cylinder and steam chest about 4 in. long and about one-third the way around the upper side.

The engineer had taken out the piston the day before the wreck to replace a broken ring and failed to make the locknut tight enough on the rod next to the crosshead. The engine ran smoothly for four hours up until about a minute before the wreck, when it began to pound, the piston striking harder every revolution. The engineer ran to the throttle and closed it just as the wreck happened.

The engine is an 8x12-in. slide-valve, running about 240 r.p.m. at 130 lb. gage and was used for threshing grain and running a portable sawmill. It had been in service about four years.

M. W. UTZ.

Minster, Ohio.

## What Causes the Sediment?

We have been experiencing much trouble with our feed water, which contains a large amount of very fine red sediment. Before being heated in the boilers the water is clear, but when it is heated the sediment settles and is very hard to wash from the boilers. When the blowoff is opened the water issuing forth is almost blood red. Surface water is used.

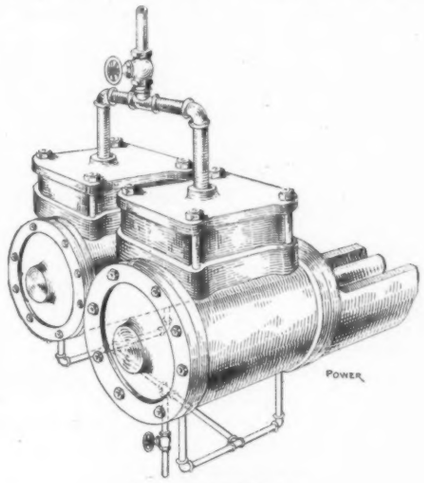
The boilers are blown down every morning and washed thoroughly every week. As we do not know the cause of our trouble, we trust some fellow engineer may help us.

W. V. KING.

Seymour, Iowa.

## Pump Drip Piping

A few days ago I was called to look at a feed pump that would not pump water into the boiler, but would pump it into a tank. The pump was new, and for the first two or three weeks it worked all right. I told the engineer to start it up and let me see what it would do. He started pumping into the tank. After it was running he reached down and closed the drips on the steam cylinder, but he only shut one valve. I looked at his piping and found that he had connected all of the drips to one pipe with a valve on the main drip pipe.




PIPING OF DRIPS

I put a valve on the drip of each cylinder. After the change the pump worked properly.

FRANK H. CORDNER.

Bradford, R. I.

## Where Should the Coil Be Placed?

I would like to hear from POWER readers who have had experience with a coil placed at the rear end of a horizontal tubular boiler, for the purpose of heating water for domestic use, such as washing and cooking.

What material should be used, and is there any danger of explosion of the pipe; also, what precautions should be taken, and what method used in piping it up? What is the best location for the coil to obtain the best results?

Stewart, Nev. ANGELO BELMONTE.

## Priming Centrifugal Pumps

In our plant we have two turbine-driven centrifugal pumps which are located above the hotwell from which they take the discharge from the condenser and raise it to a tank on the roof. An injector is used to prime both pumps and proves much more practicable than the small service pumps formerly used.

HERBERT LEIGH.

North Andover, Mass.

# Questions Before the House

**Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues**

## Effect of Air in Steam

Referring to W. A. Fullgraf's question in the issue of Mar. 26, my experience has been that a leaky suction on the boiler-feed pump will greatly impair the vacuum in a condenser. I had one case where the vacuum dropped to 22 in. and after searching for the cause, I found a leak in the valve stem of a globe valve located in the suction pipe of the feed pump. Shortly after tightening the gland nut the vacuum rose to 25 in.

I think a leak here gives more interference with the condenser's operation than one of the same proportion in the condenser air pump, owing to the air increasing in volume on account of the higher temperature in the boiler.

H. R. ROCKWELL.

Alton, Ill.

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Too much air in the steam would destroy the vacuum. The amount necessary to seriously interfere with the operation of the condenser will depend entirely upon the type of condenser and the conditions under which it works.

It is doubtful if enough air could enter the feed pipe to give trouble, especially if the pump had to lift its water; if the leak was great enough the feed pump would not lift the water. If the water flowed to the pump by gravity the water would leak out and the air could not leak in. Under such conditions the pump would pound so badly that it would be necessary to stop it.

Condensers will not work satisfactorily if a large volume of comparatively cold air is admitted to them, as in the case where a freshly fired boiler in which the air has not escaped is cut into service.

L. JOHNSON.

Exeter, N. H.

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Air in the steam will, when steam is discharged into the condenser, turn it into water, leaving the air in the condenser, and partially, or wholly, according to the amount of air, destroy the vacuum.

Pumping air into the boiler because of a leaky feed-pump suction, means the enlargement of the original volume of the air in proportion to the temperature to which it would be raised, which would be the temperature of the steam.

A leaky circulating pump would have no effect on the vacuum at all, unless it were large enough to prevent the pump from delivering the required amount of circulating water. On the other hand, if there was a leak in the air pump, it could have no direct effect on the vacuum, as it would not admit air into the condenser, but would simply minimize or totally destroy the serviceability of the air pump, thus preventing the air from being removed from the condenser and consequently destroying the vacuum.

VICTOR BONN.

New York City.

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The most annoying leaks affecting the vacuum in condensers are those in the valve stems and flanges of the exhaust main leading to the condensers. These leaks are easy to find by applying a candle flame at the joints, as the flame will be drawn inward if a leak exists.

In cutting in a boiler where no provision is made for the air to escape as the steam pressure begins to rise, it will be noticed that the vacuum will quickly drop from 5 to 10 in., depending on the amount of air in the boiler and on the kind of condensing system.

I cannot see how an air leak in the suction pipe of a feed pump, the leak not being sufficient to prevent the working of the pump, could reduce the vacuum in the condenser more than 1 in. at the most, as it would immediately pass from the boiler with the steam and in such a small quantity that the average jet condenser could take care of it.

A surface condenser having an air pump in addition to the circulating pump could take care of a considerable volume of air without any noticeable effect on the vacuum. I have had a large duplex pump feeding eight boilers where the suction pipe leaked so badly at the joints that if it were slowed down to half speed it would lose the water and have to be primed to get it started again. A jet condenser was used and the gages indicated 25 in. of vacuum, while the highest vacuum obtained under full load and normal conditions was 26 in.

R. A. CULTRA.

Cambridge, Mass.

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Air in a condenser is the chief obstacle to obtaining a high vacuum, regardless of the manner in which it found its way in. If it comes in with the steam, it is at a high temperature, but not any higher than that of the steam in the condenser. If it enters through a leaky circulating pump it mingles with the steam and reaches the same temperature in a very short time.

A leaky air pump would be a greater source of trouble because it could not be depended upon to remove the air from the condenser and maintain a high vacuum. If the feed pump lifting the feed water leaked to any extent, it would soon show by refusing to lift the water, especially if the feed was rather warm, thus making the chances of carrying a large quantity of air over with the feed rather doubtful.

M. S. WEIL.

Philadelphia, Penn.

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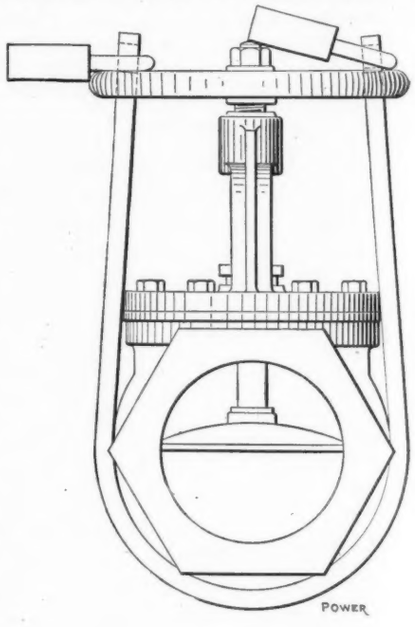
## Valve Locking Device

The locking devices described by John Thorn in the Mar. 12 issue remind me of a locking device that I have used with success on blowoff valves and feed lines.

I had been having considerable trouble with the engineer boys that were in charge of the different plants under my supervision. They would first flood the




boilers and then some of them would naturally open the blowoff valve in order to drain off some of the water. Other boys would run to notify me and they would sometimes get me up in the middle of the night. Finally, one night they ran one boiler dry. Of course, this meant extra work for me, expanding tubes and calking seams. Right after that, I got busy scheming up a locking device. The

one I use is shown in the accompanying figure and consists of an iron strap bent into a U-shape. This passes around the body of the valve and through the handle. A lock at each end keeps it in place.

ANGELO BELMONTE.

Carson Indian School, Stewart, Nev.

## Gage-Glass Fracture

The gage-glass fracture described by Richard Swartz in the Mar. 26 issue has happened many times.

In blowing steam through the glass to clear it of sediment, it is possible that a small piece of scale or other hard substance is detached from the pipe leading to the column, and, as the steam assumes a circular movement in rushing through the glass, it carries the hard substance in question with it. The probabilities are that the substance will follow the inner surface of the glass, slightly scratching it, and engineers know what a slight scratch is required to cause a gage-glass to crack.

JOHN THORN.

London Junction, Ont.

## Gage-Glass Background

In making a background for a water gage-glass, I have found the following method to give good results:

Cut a piece of tin or other bright metal to fit in back of the gage-glass. Then polish the surface that is next to the glass, after which paint black strips ¼ in. wide and ¼ in. apart so as to stand about 45 deg. with the plate in a vertical position. The space above the water line will then show the correct angle of the stripes, but those below the water level will appear at a different angle.

Another good way is to paint a ¼-in. stripe running the full length of the background, and located directly back of the glass. Above the water line the stripe will appear normal, while below it the stripe will widen to the size of the glass.

O. L. SHERMAN.

Duluth, Minn.

## Comparative Efficiency of Boilers

To my mind, in considering the above subject in the Feb. 13 issue, the question of efficiency may be divided into two distinct lines; one is the narrow question as to the boiler which will evaporate the most water per pound of coal, and is probably the efficiency which is most commonly used. The other is the efficiency, meaning coal cost, interest, maintenance and depreciation.

Along the first line, there is a decided difference of opinion as to these two types of boilers. Many believe that so long as the pressure is within the range of a horizontal return-tubular boiler, it is more efficient than the water-tube up to sizes where a boiler of this type can be economically built. What this size is, depends largely upon personal opinion. There seems to be no reason why boilers of this character cannot be built up to 84 in. in diameter with perfect success and carry steam pressures as high as 175 lb. Above this size and pressure, the water-tube boiler is better adapted, not because of greater efficiency but because of greater safety.

Water-tube boilers are as a rule set to accommodate the coal which may be used under them, and thus are arranged for the utmost efficiency, but this is by no means the case when horizontal return-tubular boilers are set; the location of the grate with reference to the shell is as a rule fixed and varies but little from the original settings developed many years ago. It is believed by many that this character of setting is by no means satisfactory when it comes to expecting the highest efficiency; I here refer to efficiency in the narrow sense. All of the developments and improvements in the settings—such as the lowering of certain types of patented gratebars, the installation of extra arches, and many other expedients—are for the sole purpose of removing one of the great objections to the present setting. It is done for the express purpose of thoroughly mixing the gases which may be distilled off the coal, with enough air to make them ignite properly and thoroughly burn them in the firebox. When boilers of the return-tubular type are properly set, and using good water and having good care, even higher efficiency may very often be obtained from them than from any of the water-tube type. The same condition holds true as regards thorough efficiency, meaning the cost of steam in dollars and cents.

Recently it became necessary to install a considerable increase in capacity in a power plant. The pressure required was 150 lb. By installing two 84-in. boilers, it was possible to get 596 hp. in the same space that was required for 500 hp. of water-tube boilers. It seems to be general practice also to underrate tubular boilers to a greater extent than is common with water-tube boilers.

Taking these factors into consideration, it is hard to conceive why, with moderate pressures, anyone can claim that a water-tube boiler is more efficient than a fire-tube in either the broad or narrow sense.

So far as output is concerned, there seems to be no reason why, if desired, the same amount of coal per square foot of grate surface could not be burned under a horizontal return-tubular boiler as under a water-tube. It all depends upon the draft which may be obtained, and whether the heat can be removed from the gases before they reach the stack. This relates to a question of design, and my practice leads to the opinion that it can be accomplished with the return-tubular type without involving difficulties of installation or operation. When it comes to higher pressure, the marine type of Scotch boiler has in many instances shown as high efficiency as the best types of water-tube boilers.

The water-tube boiler is only advantageously adapted to service where it has to meet very sudden fluctuations in load and where the pressures are very high. Return-tubular boilers can be built up to any pressure, but, owing to the extreme thickness of plate required, it is doubtful if they are quite as efficient and, owing to the strains to which they are subjected, they are far more dangerous under these conditions than water-tube boilers.

HENRY D. JACKSON.

Boston, Mass.

## Grease for Valve Stem Bearings

Replying to G. Berna's letter in the Mar. 19 issue under the above title, I say his plan is a good one. I make a practice of using cylinder oil for lubricating the valve-stem supports and also for lubricating all other parts of a Corliss or similar valve-gearing; I believe engine oil is entirely too light to do much lubricating where it is affected by heat radiating from the steam ports and cylinder.

Engine oil smokes and burns off about as fast as it reaches the bearings, whereas if grease or cylinder oil is used on all wearing parts, it will have body enough to stand the heat and keep the bearings and rubbing surfaces well lubricated.

THOMAS BAKER.

New York City.

## Low Water in a Boiler

Here is what one fireman did to a boiler under my charge. We sunk a well outside the power house and when water was reached it was necessary to keep a pump going night and day, so the contractors agreed to furnish a man to keep steam up at night in the power-house boiler.

The new man arrived and for five nights all went well. One morning when I came in I found that one of the assistant engineers had pulled the fire, as the fusible plug had blown out. The assistant said he had found the fireman excitedly walking the floor. There was about 10 lb. of steam in the boiler but no water showed anywhere in the glass and the fire was partly banked.

The fireman said that he could not get water into the boiler, but the blowoff valves showed evidences of having been opened and the blowoff tank was full of water, which proved that he had blown a large quantity of water out of

the boiler; whatever he had done, he could give no lucid account of his actions.

After the boiler had cooled sufficiently, the engineer, being satisfied that there was considerable water in it, allowed more to run in very slowly until it showed in the glass, and then he built up the fire. When there were about 20 lb. of steam, the fusible plug blew out, which showed that it had been partially melted before, it then being necessary to pull the fire. After a new plug had been put in, a water pressure of about 45 lb. was put on the boiler, at which the seams showed leaks on the under side of the drums and they had to be calked. There were no other signs of overheating or warping of the parts, and after the calking was finished steam was raised and everything seemed all right.

From the evidence it would appear that the water rose high enough to fill the gage-glass and then the fireman went to blow it down and allowed so much to run out that he was not sure whether he had any water. The feed pump and other apparatus were in perfect working condition, and in addition there was an independent supply of water under the city pressure with which he could have fed the boiler by dropping the steam to 40 lb. The valve on the feed pipe was also found closed, which showed that he was at loss to know what to do.

G. H. KIMBALL.

East Dedham, Mass.

## Why Does the Pump Race?

I have had the same experience as related by W. T. Moulton in the Apr. 2 issue under the above heading. To understand the reason for the pump's actions it is necessary to take into consideration the relation between the temperature and the pressure of steam. In the open atmosphere water boils at 212 deg. F., but at a pressure of 4 lb. gage the boiling point is about 225 deg., and with his dry return the water in the receiver will probably not be much below this temperature.

When the steam pressure is shut off from the heating system, the pressure in the receiver immediately drops and ebullition of the water will take place, due to the extra heat it contains, and the pump becomes steam-bound as a result. If Mr. Moulton will insert a thermometer in the suction pipe of his pump I think he will find that the water is above 212 deg. F.

The equalizing pipe referred to is an excellent and very important feature, as it insures a steady return and constant speed of the automatic pump, and prevents any tendency of the steam to short-circuit through any part of the system. What he calls the equalizing tank is simply a pump governor, and could be eliminated by placing the float in the main receiver.

As a remedy for his trouble it is only necessary to take the precaution to close the throttle of the pump before shutting steam off the system. After a few minutes the water will cool sufficiently to pump out the receiver.

Mr. Moulton may be interested in my letter on this same subject which appeared on page 649 of the issue of Oct. 24, 1911.

E. W. CLINEHENS.

Troy, Ohio.

When the valve controlling the steam heating is closed, Mr. Moulton's pump will run all right so long as some pressure remains on the system. As soon as he opens his vacuum-breaker he relieves the pressure in the return tank and the vacuum formed in there due to the steam condensing prevents the water from running by gravity to his pump and causes it to race and pound.

If he will place a swinging check valve, open to atmosphere, in a horizontal pipe in place of his vacuum-breaker valve, the vacuum will automatically break when the pressure falls and prevent the pump from racing.

W. J. BAILEY.

Bedford, Ind.

It would seem that the receiver tank is not high enough above the pump; 4 lb. pressure in the heating system acts on the pump the same as a head of water about 9.25 ft. The pump therefore handles the hot returns as the water is forced to the suction chamber.

When the heating system is shut off, all this is changed. The pump no longer has pressure in the system to force the water to it, but only the head due to the height of the receiver tank, which is not sufficient to overcome the tension of the suction-valve springs. The pump must create a vacuum in the plunger chamber to allow the water to enter.

The boiling point of water in a vacuum is much lower than at atmospheric pressure, and as the plunger moves away to create a vacuum, the water in the clearance space of the chamber tends to break the vacuum as fast as it is created. This condition will exist until the temperature of the water in the receiver and piping has dropped considerably.

The remedy is to lower the pump or elevate the tank above its present position.

WILMER R. HERSEY.

Milford, Mass.

## Joining Leather Belts

Commenting on the letter by F. S. Rise on the above subject, in the issue of Apr. 2, I have seen wire used for joining belts in a machine shop, and while it held the belts in good shape and in some respects was better than leather laces, there were some disadvantages which caused it to be discontinued. The principal reason for giving it up was because of the danger of cutting the hands in shifting the belts and in replacing those that had come off the pulleys.

The same fault can be found with most metal fasteners; while such fasteners can be used to good advantage on belts that do not have to be handled while running, I believe the old-fashioned leather lace is best for lathe belts and others that have to be shifted while in motion.

C. E. HOLLEY.

Bessemer, Mich.

## Damper Regulator

Answering Mr. Smith's inquiry in the Mar. 26 issue as to the economy of using a damper regulator, my experience has been that its use has shown a marked economy.

In one plant there was a regulator, but no means of checking the results from its use. In another, the coal was weighed and a thorough account kept of all water evaporated and work done. By testing with and without the damper regulator in service, the results were easily obtainable.

These tests showed an increase of about 3 per cent. in economy when the regulator was used over that obtained when it was out of service. The steam pressure was much more uniform, too, as was shown by the recording steam gage.

The opening of the damper by the regulator is of great assistance to the fireman in maintaining a uniform furnace temperature, as when it operates to open, it is the surest indication that the fires need attention.

VICTOR JUMP.

Caledonia, Ohio.

When proper facilities and good management are used in conjunction with a damper regulator there is a decided economy in the plant operation.

In plants where there are a number of stand-by boilers connected to the line with the firing boilers, taking care of steam and load fluctuations, there may be eight or ten boilers being coaled at one time. Under such conditions it is next to impossible to maintain a uniform $CO_2$. When the damper opens there is an excess of air admitted, but the fires become hotter more quickly, and a uniform steam pressure is obtained. Shortly after the damper closes the $CO_2$ rises to a maximum, and soon the stand-by boilers are making steam.

Such conditions may be improved and a greater economy realized if each set of firing boilers is provided with a damper regulator, and each regulator set to operate at about 3 lb. greater pressure than that on the adjoining set of boilers.

Lebanon, Penn. N. AUCHENBACH.

# Inquiries of General Interest

**Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it**

## *Armstrong Shaft Governor*

What is the function of the slot in the end of the lever of an Armstrong shaft governor?

L. J. I.

The slot in the end of the lever is for adjusting the regulation. For closer regulation and more sensitiveness, move the pin in the slot closer to the shaft center, to make the regulation more sluggish, to put a stop to racing, move the pin toward the rim of the wheel.

## *Reversal of Current*

What prevented the circuit-breaker of a 60-hp. motor from tripping when the generator that supplied current to it "reversed"?

B. J. C.

Reversal occurred so quickly that the motor did not have time to slow down far enough to take sufficient accelerating current to trip the circuit-breaker.

## *Cutoff af a Slide Valve*

On what part of the stroke should the cutoff of a slide valve occur?

H. W. C.

Usually the slide valve is designed to cut off at about five-eighths of the stroke; by adding lap to the valve, the cutoff will be earlier, but the eccentric must be advanced to give the same admission, which makes the cutoff earlier still. It is impossible to get full port opening with a cutoff earlier than half the stroke.

## *Feed Water Heaters*

What is the heat transmission per degree difference in temperature per square foot between the steam temperature and the actual average temperature of the feed water of a feed-water heater?

W. H. C.

It depends upon the velocity of the water passing through the heater, whether the water or the steam passes through the tubes and the material of which the tube is made. A good average figure for water-tube multi-flow heaters is 250 B.t.u. per square foot per hour for plain brass or copper tubes, and 300 B.t.u. for corrugated tubes with a water velocity of 50 ft. per minute; for single-flow heaters, 175 B.t.u. for plain brass tubes with a water velocity of 12.5 ft. per minute, and for coil heaters, 300 B.t.u. for copper tubes with a water velocity of 150 ft. per minute. For steam-tube heaters with iron tubes a good average figure is 120 B.t.u.

## *Horsepower Required by a Motor Driven Crane*

What would be the load in amperes of a 240-volt direct-current motor operating a crane and raising a load of four tons, 175 ft. in one minute; the efficiency of the motor being 85 per cent. and of the crane 65 per cent.?

D. B. A.

The work required to raise the load is

$$8000 \times 175 = 1{,}400{,}000 \text{ } ft.\text{-}lb.$$

As the efficiency of the crane is only 65 per cent., the work required by the motor would be

$$\frac{1{,}400{,}000}{0.65} = 2{,}153{,}846 \text{ } ft.\text{-}lb.$$

One watt is equivalent to 44.265 ft.-lb. per minute; therefore since the weight is lifted in one minute, the power expressed in watts delivered by the motor is

$$\frac{2{,}153{,}846}{44.265} = 486{,}579.9 \text{ } watts$$

and the ampere load required by the crane would be the watts divided by the volts, or

$$\frac{48{,}692}{240} = 202.74 \text{ } amp.$$

As the efficiency of the motor is 85 per cent., the ampere load required by the motor would be

$$\frac{202.74}{0.85} \quad 238.51$$

## *To Obtain the Temperature of the Furnace*

What apparatus is necessary and what is the rule to obtain the temperature of a furnace with a metal ball?

K. C. G.

A large pail three-quarters full of water having a tight-fitting cover in which a hole is bored and a perforated tube as long as the pail is deep inserted, a metal ball and a thermometer are required.

Heat the ball to the temperature of the furnace, and before removing note the temperature of the water by the thermometer fixed in the tube. Remove the ball from the fire and quickly immerse the ball in the water, replace the cover, and note the highest reading of the thermometer. To calculate the temperature of the furnace, divide the weight of the water in pounds by the weight of the ball, and multiply the result by the difference between the highest reading of the thermometer, and the reading before the ball was immersed; divide the product by the specific heat of the ball and add the final temperature of the water. Example: Weight of ball, 4.2 lb.; weight of water, 38 lb.; temperature of the water before immersion, 64 deg. F.; after immersion, 108 deg. F. Substituting figures, the rule would be thus expressed as a formula:

$$\left(\frac{38}{4.2} \times (108 - 64) \div 0.166\right) + 108 =$$

$$2506.7 \text{ } deg. \text{ } F.$$

The specific heat of cast iron at the temperature of the boiler furnace may be taken at 0.166.

## *Coal Required to Run an Engine*

If a steam-engine plant converts 9 per cent. of the available energy in the coal into mechanical work, how many pounds of coal per hour will be required for a plant with an output of 500 hp.?

A. W. N.

The foot-pounds of work developed by the engine per hour is

$$500 \times 33{,}000 \times 60 = 990{,}000{,}000 \text{ } ft.\text{-}lb.$$

and the heat units required would be

$$\frac{990{,}000{,}000}{778} = 1{,}272{,}493 \text{ } B.t.u.$$

This is 9 per cent. of the heat energy which the coal must furnish. One hundred per cent., or the heat required, would be

$$\frac{1{,}272{,}493 \times 100}{9} = 14{,}138{,}811 \text{ } B.t.u.$$

Assuming each pound of coal to contain 14,000 B.t.u., there would be

$$\frac{14{,}138{,}811}{14{,}000} = 1009.9 \text{ } lb.$$

of coal required.

## *Grate Surface of Steam Boilers*

Which would be the most desirable of two boilers, alike in every respect, with the exception that one has a larger grate surface than the other?

P. A. R.

With other things equal, the boiler with the larger grate surface is to be preferred. The boiler may be driven, should the occasion require, and it will give the rated capacity with a poorer grade of coal than the other. Too large a grate surface can be overcome by shortening the grate; too small a grate surface necessitates using a high-priced fuel and more frequent cleaning of fires.

## Answers to Study Questions

The following are answers to the questions asked in the issue of Apr. 23:

1. Cast iron weighs 0.2604 lb. per cubic inch. The weight of the ball will be

$$64 - 3 = 61 \text{ lb.}$$

and its volume will be

$$61 \div 0.2604 = 234.25 \text{ cu.in.}$$

To find the diameter of a sphere, divide its volume by 0.5236 and extract the cube root of the quotient. Substituting figures, the rule is expressed as follows:

$$\sqrt[3]{\frac{234.25}{0.5236}} = \sqrt[3]{447.4} = 7.646 \text{ in.}$$

in diameter.

2. The heat contained in 1 lb. of steam at 90 lb. gage pressure, or 105 lb. absolute, is 1187.2 B.t.u. above 32 deg. F. The engine is capable of heating the feed water to 212 deg. F. and that amount of heat should be credited to the engine. Water at 212 deg. contains 180 deg. above 32; therefore the net heat supplied to the engine per pound of steam is

$$1187.2 - 180 = 1007.2 \text{ B.t.u.}$$

and 28 lb. of steam will deliver to the engine

$$28 \times 1007.2 = 28{,}201.6 \text{ B.t.u.}$$

A horsepower-hour is equivalent to

$$33{,}000 \times 60 = 1{,}980{,}000 \text{ ft.-lb.}$$

and an ideal engine will require per horsepower per hour

$$1{,}980{,}000 \div 778 = 2545 \text{ B.t.u.}$$

To produce 1 hp. per hour 28,201.6 B.t.u. are required. The thermal efficiency of the engine is

$$\frac{\text{B.t.u. value of hp.}}{\text{B.t.u. used by engine}} = \frac{2545}{28{,}201.6} = 0.09024 = 9.024 \text{ per cent.}$$

3. A draft is created by the difference in weight between the hot gases in the chimney and the cold air outside. The cold air, being heavier than the hot gases, will flow into the furnace and force up the column of lighter hot gases. The draft will vary according to the difference in weight between the hot gases and the cold air, which depends upon the difference in temperature between the hot gases and the entering air, and the height of the column.

4. To find the diameter of the material in an open-link chain to safely carry a given load, divide the weight to be carried by 13,350 and obtain the square root of the quotient. The constant 13,350 is good for general conditions; it varies from experiments made by different authorities from 13,440 to 13,750. Substituting figures, the rule would be expressed thus:

$$\sqrt{\frac{34{,}700}{13{,}350}} = 1.612 \text{ or } 1\tfrac{5}{8} \text{ in.}$$

diameter.

5. To determine the centrifugal force of the balls in pounds, multiply the weight of one of the balls in pounds by the square of the velocity of the ball in feet per second and divide the result by the product of 32.16 and the radius of the path described by the balls. Expresesd as a formula, it would be

$$F = \frac{W v^2}{g r}$$

where

$F$ = Centrifugal force in pounds;
$W$ = Weight of the body in pounds;
$v$ = Its velocity in feet per second;
$r$ = Radius of the path in feet;
$g$ = Acceleration due to gravity, or 32.16 ft. per second.

Substituting figures, the formula would be expressed as follows: 282 ft. per minute would be

$$282 \div 60 = 4.7 \text{ ft.}$$

per second.

$$\frac{12 \times 4.7^2}{32.16 \times 1.25} = 6.594 \text{ lb.}$$

## Portland Regrade Operation

Eastern cities may well look to some of their Western sisters for progressive ideas in civic improvement. It is well known that Seattle, Wash., has in recent years veritably remodeled herself. From a city of steep hills she has been changed to one of gentle grades. This great project was eminently successful, largely because of the use of modern electrical and mechanical hydraulic apparatus.

Portland is now following suit by hydraulically reducing an abrupt prominence within her limits known as Goldsmith's Hill. Because of the great satisfaction given by the motors used to operate the pumps which washed the hills of Seattle into the sea, these same motors were later taken to Portland where they are now being used to drive the pumps in the regrading there.

The composition of Goldsmith's Hill is especially gravelly. The streams, therefore, are directed by large nozzles so as to undermine the lower part of the bank, and the weight of the material above brings down the sand and gravel from the working face. From here it is washed through the sluice way into Guild's Lake. In some places the height of the bank to be reduced was 140 ft.

It is expected that by the spring of 1913 the hill will be leveled and its site will be suitable for no less than 300 residences, while the operation will reclaim to the city several acres of land from Guild's Lake, half a mile away.

The motors are of Westinghouse make and rated at 650 hp., 690 r.p.m., 2300 volts, two-phase, 60 cycles, each being direct-connected to two Worthington five-stage turbine pumps. The pumping service is amplified by the addition of a booster unit consisting of a volute pump directly connected to a 900-hp. induction motor.

The pumping plant is capable of supplying 500,000 gal. of water an hour at a pressure varying between 200 and 300 lb. per square inch according to the demand. Electric energy is supplied by the Portland Railway, Light & Power Co.'s plant.

## Device for Preventing Smoke

The Furnace Gas Consumer Co., of Matteawan, N. Y., has recently placed on the market a device for eliminating smoke when burning bituminous coal. Its operation involves nothing new or mysterious but, instead, it is an application of well established principles, in which connection it would perhaps be

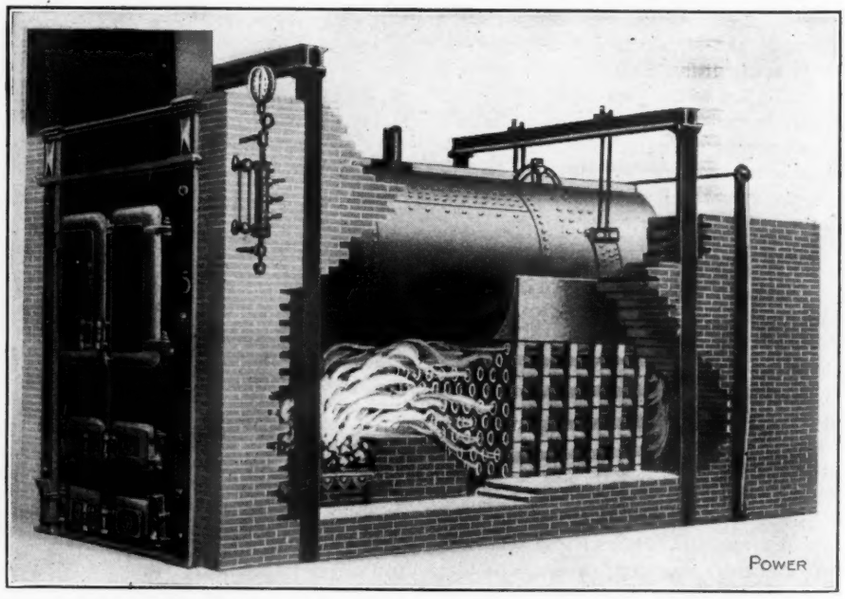



FIG. 1. DEVICE APPLIED TO RETURN-TUBULAR BOILER

more correct to designate it as a "smoke preventer" rather than a smoke consumer.

It is well understood that when bituminous coal is burned, heavy hydrocarbons are at first distilled off. In order that these may be consumed, two conditions are necessary: sufficient air must be supplied for complete combustion and a sufficiently high temperature must be maintained; cooling of the gases before the combustion is complete will result in smoke. A simple experiment will perhaps serve best to illustrate this.

Consider an ordinary kerosene lamp. When burning freely with sufficient air the flame is bright and clear, without a sign of smoke, but by gradually cutting off the supply of air the lamp will begin to smoke. Furthermore, if the chimney be removed and a cold body be introduced into the flame, smoke and soot will result. This is analogous to the hot gases in a boiler coming in contact with the colder tubes before combustion is complete. Once the distilled gases from the coal have come into contact with the comparatively cool boiler surfaces, they will not burn again unless mingled with air at a temperature sufficiently high to effect ignition.

This is just what the device under consideration is designed to accomplish. It consists of a series of refractory tubes set in the path of the gases just back of the bridge-wall, in such a manner that the gases arising from primary combustion pass through them before reaching the boiler flues. The tubes, which are 12 in. long, are placed end to end in four or five sections and are held in place without any mortar by blocks of suitable shape. The total free area through the tubes forms about 45 per cent. of the area across the furnace and is slightly greater than the area through the boiler flues. As the tubes form a continuous passage from end to end, accumulations of dust are easily blown out. Furthermore, no changes are required in the boiler setting, the device merely occupying space heretofore wasted behind the bridge-wall.

Fig. 1 shows it applied to a return-tubular boiler and Fig. 2 to a water-tube boiler having horizontal baffles. In the present form it cannot be applied to a water-tube boiler with vertical baffles.

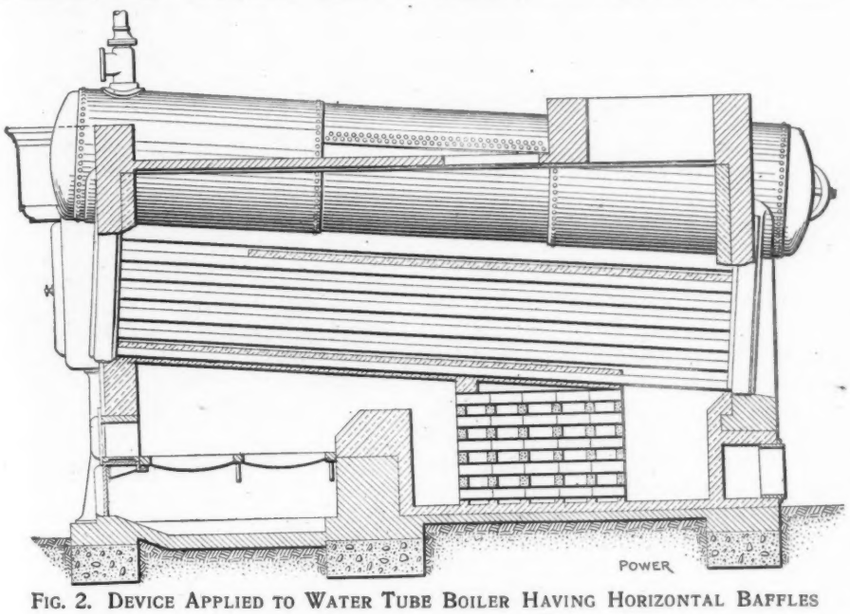



FIG. 2. DEVICE APPLIED TO WATER TUBE BOILER HAVING HORIZONTAL BAFFLES

Besides aiding in a more perfect combustion of the gases and thus eliminating smoke, the device provides a means for storing heat which helps the steaming capacity over periods of load fluctuation and also tends to keep up the steam pressure while the fires are being cleaned. During the latter operation the hot refractory tubes prevent any cold air from reaching the boiler flues.

This heat-storage value is very forcibly illustrated by the fact that when the fires are banked over night the steam gage will work up to the blowing-off point within a few hours and after being reduced about 10 lb. by the introduction of cold feed water, it will remain at about that pressure till morning.

One of these devices is installed under a 6x16-ft. return-tubular boiler at the plant of the Ellrodt-Lynch Co., of Matteawan, and has been tried out very completely. During February a series of three tests, each covering four days, were made on this boiler. Each test consisted of four runs, the first three at normal load with anthracite coal and the fourth day at maximum load with bituminous coal.

The first test was made without the smoke-preventing device installed, the second with two sections in place and the third with four sections. A very noticeable result of these comparative tests was that the loss of draft through the refractory tubes was practically the same with two and four sections installed; namely, about 0.1 in. The principal results of the tests with bituminous coal are given in the accompanying table.

Numerous observations have been made for smoke and it is claimed that only for two to three minutes at the time of firing is smoke visible.

COMPARATIVE RESULTS OF TESTS WITH BITUMINOUS COAL

| | Test No. 1 Ordinary Setting | Test No. 2 Two Sections of Tubes in Place | Test No. 3 Four Sections of Tubes in Place |
|---|---|---|---|
| Heat value of fuel, B.t.u. per pound | 14,310 | 14,240 | 14,610 |
| Duration of trial, hours | 11 | 11 | 11 |
| Steam pressure, gage | 105 | 104.7 | 106.2 |
| Temperature of feed water, deg. F | 32 | 32 | 32 |
| Average temperature of gases at back of boiler | 1,390 | 1,525 | 1,544 |
| Maximum temperature of gases at back | 1,600 | 1,790 | 1,800 |
| Average temperature of gases leaving boiler | 513 | 511 | 511 |
| Maximum temperature of gases leaving boiler | 565 | 545 | 545 |
| Draft in uptake inches | 0.4 | 0.5 | 0.45 |
| Draft at back of boiler, inches | 0.3 | 0 35 | 0.2 |
| Draft over fire, inches | 0.3 | 0.25 | 0.1 |
| Boiler horsepower developed | 178.1 | 181.3 | 194.1 |
| Equivalent evaporation from and at 212 deg. per pound of dry coal, pounds* | 9.63 | 10.04 | 10.41 |

*Uncorrected for quality.

## Bill to Regulate Hydro-electric Developments

A bill to regulate the development of hydro-electric power in American navigable waterways was recently introduced in Congress under which those desiring to construct or operate plants must first obtain Government sanction.

It is proposed that an annual rental of $1 per horsepower developed be paid to the Government, this rate to be subject to readjustment every 10 years. If, however, a disagreement arises over this rate, that for the next 10-year period shall be double that of the preceding period; a reasonable rate will then be fixed by the courts.

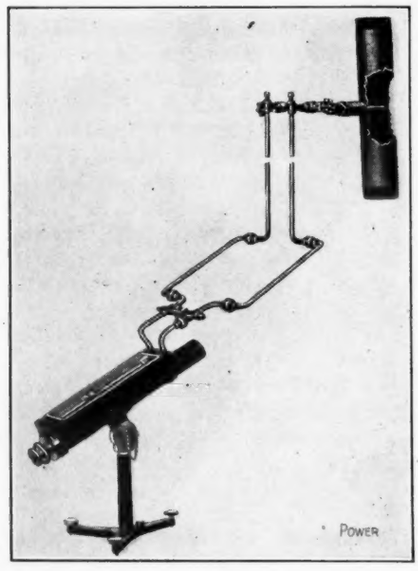
This bill would also permit the Secretary of War, when authorized by Congress, to purchase the buildings and equipment of the grantee at the expiration of the term for which the permit was issued. No permit would be issued for a longer period than 50 years.

## Portable Induction Meter

Several types of G. E. flow meters have been described in these columns (see page 1015, June 27, and page 154, Jan. 25, 1911, issues). The type F W-2 meter operates with the same design of pilot tube that is used with the types R W-2 and F W-2 meters previously described.

The meter, illustrated herewith, is a portable indicating instrument giving instantaneous values of the rate of flow in gallons per minute. It can be adopted by the operator to measure the flow in pipes of any diameter at any temperature within its range. On account of its simplicity, light weight and flexibility, it is especially useful for general testing work, locating leaks, etc.

The meter consists of a U-tube with glass legs, which are filled for part of their height with mercury. Located centrally with respect to the glass tube is a cylindrical chart from which is read the rate of flow in gallons per minute. Suitable auxiliary scales are provided so that the indication is correct at any condition of temperature and for pipes of various diameters within the range of the meter.




INDICATING FLOW METER

The U-tube system can be inclined from a vertical to a nearly horizontal position by revolving it about its point of support. If the velocity of the water is high, the meter may be set in the vertical position; if, on the other hand, the velocity is low it may be inclined toward the horizontal. In this manner the meter can be readily adjusted to accurately measure very high or very low velocities.

The adjustments of the meter for the proper pipe diameter and temperature of the water at the point where the nozzle plug is installed are made by rotating the graduated scales at the lower end of the meter. The two sights are set to coincide with the meniscuses of the mercury in the glass U-tube. The indication of the pointer on the chart multiplied by a constant depending upon the inclination of the meter from the vertical and by the area of the pipe in square inches will give the total rate of flow in gallons per minute.

The meter may be used to measure the flow under normal conditions in any number of different pipe lines if they are more than 2 in. in diameter. It is only necessary to provide the pipe with a nozzle plug of the proper length to which plug the meter can be connected.

The meter is calibrated to read in gallons per minute at 39.1 deg. F. This instrument is manufactured by the General Electric Co., Schenectady, N. Y.

## Non-Leaking Damper Frame

Owing to the fact that a good deal of latitude must be given to expansion and contraction, there can be no such thing as a close mechanical fit between the damper and the damper frame of a steam boiler. One source of appreciable loss is the leakage of cold air from the outside through the crevices surrounding the damper plate. This is a most difficult matter to deal with successfully.

A simple device, however, has been in use for some time, particularly in the Manchester district in England, where problems of economy are closely studied in the large cotton-mill power plants, which appears to afford a satisfactory solution. It is made by the Courts-Turner Engineering Co., of Manchester, and is shown in Fig. 1. It will be seen that the damper frame consists of a combination of three castings the bottom one of which, *A*, is an oblong frame with a flange cast all around the top. The lower part of this casting is let into the brickwork surrounding the damper to a depth of 2½ in., so that the flange rests on the top of the brickwork and is grouted in with cement. The upper or horizontal face of the flange has a groove cast in it all the way around, and into this groove ordinary asbestos packing is inserted.

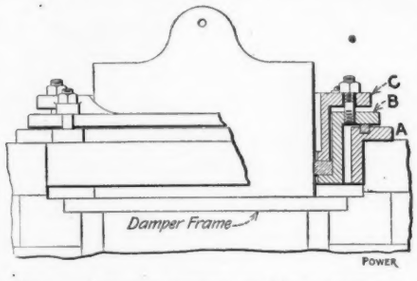



FIG. 1. CONSTRUCTION OF NON-LEAKING DAMPER

The second casting, *B*, is somewhat similar in form to the first one, and also has a flange at the top which when placed into position rests on the asbestos packing, and in this way forms with *A* an air-tight joint. There is no rigid mechanical connection between *A* and *B* and there is sufficient clearance to allow the latter to move both lengthwise and sidewise to the boiler so that it can adjust itself to the damper. This casting also forms a stuffing-box in which a length of woven asbestos packing is placed which entirely surrounds the damper. Four lugs attached to bolts passing through the frame *A* and fixed in the brickwork of the boiler setting keep the second casting from rising with the damper when it is worked.

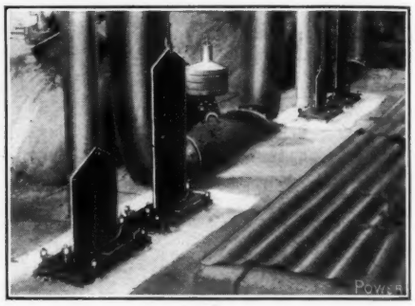



FIG. 2. AN INSTALLATION OF NON-LEAKING DAMPERS

The third casting, *C*, is similar to an ordinary gland, and brings a slight pressure to bear on the packing surrounding the damper so as to make the joint air-tight. The damper can be moved up or down quite freely and there is no fear of its binding in any way. The wear on the asbestos packing in the gland is insignificant, and therefore the leakage of air from the outside of the boiler setting to the flues past the edges of the damper is avoided.

Fig. 2 shows an installation of these dampers. It is not possible to give any data as to the possibilities of the saving to be effected as the results vary in accordance with the boilers to which the device is applied. Where economizers are employed, however, its installation should be well worth while as it helps to keep up the temperature of the entering gases and this means just so much more heat recovered from the waste gases

## Revolution Counter and Stop Watch

The instrument shown herewith consists of a revolution counter and precision nonmagnetic stop watch. The two instruments are so connected that they will simultaneously start to work the moment a slight pressure is applied to the center spindle. As soon as the pressure is released both the counter and watch will stop at the same time, thus

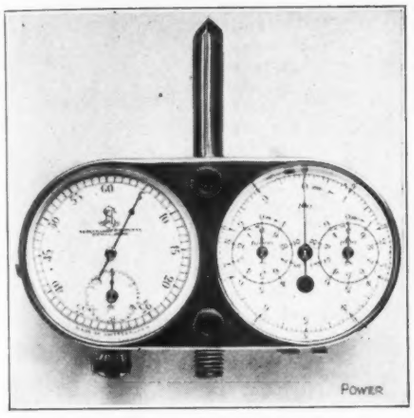
indicating on the dials the number of revolutions made by the object under test in the time elapsed.

The instrument is especially recommended for high numbers of revolutions and it can be used for any rotating shaft or spindle up to 30,000 r.p.m.

The duration of the test is indicated in minutes, seconds and fractions thereof; the small pointer on the watch dial records up to 30 min. and then repeats.

The revolution counter has three pointers which indicate from 1 to 100, 100 to 1000 and 1000 to 10,000 r.p.m., respectively.

A short test lasting 6 sec., multiplied by 10, is sufficient to measure the speed of any machine.




REVOLUTION COUNTER AND STOP WATCH

The instrument is equally useful for right- or left-hand revolutions. It can be applied to the shaft to be tested without previous knowledge of the direction of rotation. No adjusting or setting is required. The appearance of either a red or a black disk on the counter dial (shown as a black spot on the dial) indicates whether right or left rotations are being counted.

The dial figures, which correspond in color to the disk, are used in the reading. The counter as well as the stop watch can be instantly set back to zero.

The instrument is strong and has a fine grade movement. It is manufactured by Schuchardt & Schütte, 90 West St., New York City.

## Boiler Connections

BY EVERARD BROWN

In a boiler house the question of safety should come first, and all supports, pipe lines, connections, etc., should be so designed and constructed that an ample factor of safety will exist. It is possible in most all cases to so locate the steam headers, valves and piping and arrange the various connections that the whole equipment will present an appearance which will at once dissipate any fear for personal safety, for it usually follows that if proper care and attention have been given to these things one can rest assured that the whole installation has been made in a similar manner.

As is well known, there are three important factors to be considered in connecting up a boiler; namely, all connections must be of sufficient strength (with some in reserve) to withstand the internal pressure; they should be so located that no undue strains will result from expansion or contraction; and adequate drainage should be provided.

To insure the utmost safety, all pipe connections to the boiler shell, unless they are not over, say, 1 in. in diameter, should be made by means of pressed or rolled steel flanges or carefully annealed steel castings riveted to the plates. For connections 12 in. or larger, even the steel castings are being replaced to a large extent by the pressed or forged flanges. The smaller connections are usually made by tapping holes and screwing the pipe into the shell.

Under no circumstances is it advisable to use cast iron. The steam header should be placed at a sufficient distance from the nozzle of the boiler to permit the use of a gooseneck connection having a large enough radius to be capable of considerable expansion without bringing about dangerous strains on the flange connections or the nozzle. This gooseneck should be vertical and should be connected to the top of the steam header. If local conditions make this impossible, a connection on the side of the header may be made but in all cases a bottom connection should be avoided.

A stop valve, preferably of the gate type, with an outside screw and yoke, is usually located in the gooseneck as close to the steam header as possible and a nonreturn valve of the triple-acting type should also be set in the gooseneck but close to the boiler nozzle. Under usual operating conditions it is seldom necessary to operate the stop valve and it need be closed only when someone is inside the boiler so that there will be a double protection against steam coming over from the other boilers.

The nonreturn valve will automatically connect the boiler with the steam header as soon as the required pressure has been reached and when taking off a boiler this valve should be tripped by hand. In this way the valve is tested at certain intervals, thus precluding any danger of its becoming inoperative without the knowledge of the attendant.

In order to prevent any pocketing of water when the valve is closed, it is well to connect a drain pipe to each gooseneck at the proper place. These drain pipes should lead to receivers or traps which will automatically remove the collected water. Sometimes a check valve is put in these drain pipes to prevent any backward flow of steam when the boiler is out of service.

## Brooklyn Fire Bursts Boiler

A stubborn fire under iron cover on a long pier at the foot of Pacific St., Brooklyn, practically wrecked the Dow's Stores six-story grain elevator on Apr. 21.

Three fireboats made little impression until a boiler explosion in the elevator tore holes in its side and floor and gave them access. The flight of iron and timber caused the fireboats to back away several times. A laborer was injured.

## Chicago Boiler Explosion Maims Several

By the explosion of a boiler in a five-story brick building at 9 Michigan St., Chicago, on Apr. 15, several persons were injured; one, the fireman, may die. About 150 workmen in the building rushed in a panic to the street, and a telephone operator on the first floor was thrown from her chair.

The explosion, according to the daily press, wrecked the boiler-room and set fire to the upper floors, which required a general alarm before it was extinguished. No reason is given for the accident.

## Two Boiler Explosions in Pennsylvania

On Apr. 17, two boiler explosions were reported to have occurred in Pennsylvania, one in an oil-well plant, at Canonsburg, in which a man was perhaps fatally injured. No cause is given in the press report.

The other explosion happened at the fertilizer plant at Seven-Stars, near Pottsville. The shell went straight up to the roof and narrowly missed several workmen standing near by. One man was injured and is in a critical condition. The cause is unknown.

## Boiler and Flywheel Accidents

According to the April bulletin of the Fidelity & Casualty Co., from Feb. 10 to Mar. 7 there were 25 boiler explosions, and from Feb. 12 to Mar. 18, six flywheel explosions.

There were 15 persons killed and 26 injured by the boiler explosions. In the flywheel accidents three persons were killed and two were injured.

## Middlesboro Plant Wrecked by Boiler Explosion

Press dispatches state that two men were killed and several others seriously injured on Apr. 19 when the boiler in the lumber-milling plant of the Powell's River Co., near Middlesboro, Ky., exploded. The force of the explosion was sufficient to wreck the entire plant. The cause is given as low water in the boiler.

## "Titanic's" Rescued Firemen

As was to be expected, the boiler-room crew of the "Titanic" had its full share of suffering and death.

The 29 boilers and 159 furnaces demanded a force of about 180 men; 13 of the survivors are shown in the accompanying engraving. Every means were taken to provide them with money and clothing, and send them home or get them places on other ships if they desired, only a few men having been detained to give evidence before the Senate Investigating Committee.

"TITANIC'S" FIREMEN SURVIVORS

Many acts of bravery and heroic sacrifice were related by the surviving firemen. Thomas Andrews, the designer and Harland & Wolff's representative; Mr. Cummings, the builder of the engines, and ten supervising engineers who stood by to watch the engines' maiden performance, refused to leave the ship and rendered great assistance to the women and children in getting them into the boats.

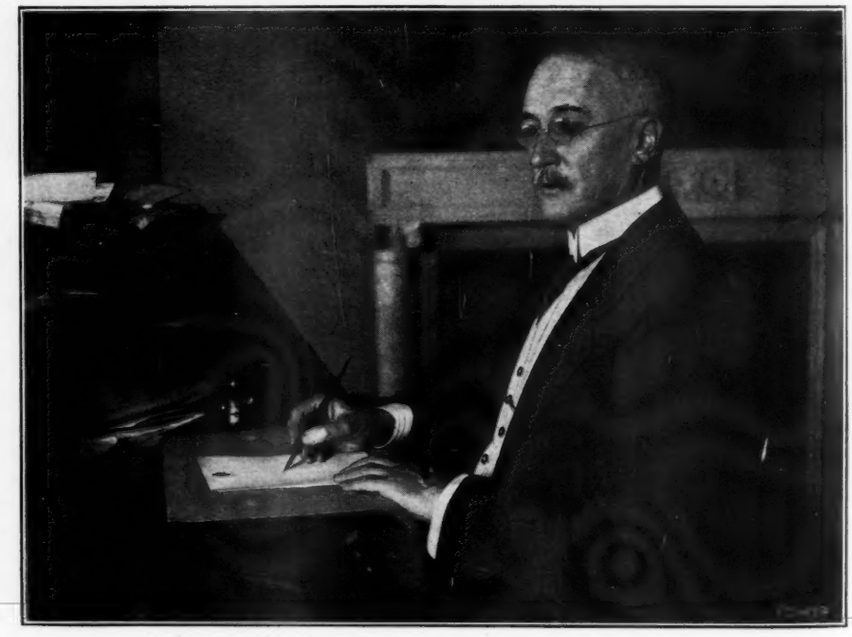
James Thompson, a fireman who is in a New York hospital recovering from his injuries, declares that he knew the "Titanic" was running at 77 revolutions (22 knots) on Saturday, and that this speed was increased on Sunday to nearly 23 knots, which was maintained up to the time she struck the Iceberg. It has never been disputed that the "Titanic" was not under full speed when she struck. Thompson further said that after three days he "hardly saw anything else but the 215 lb. on the gages as the engineers were driving the firemen to do their utmost."

Most of the men did not leave the boiler rooms until the incoming water forced them out. Some of these men were afterward picked up in the open sea, into which they had jumped a few minutes before the "Titanic" went down.

It is through the courtesy of the evening edition of the *New-Yorker Staats-Zeitung* that we are enabled to give the picture of these rescued firemen.

# SOCIETY NOTES

Rudolph Diesel, D. E., D.Sc., director of the Verein Deutscher Ingenieure and the inventor of the Diesel engine, was made, on Apr. 30, an honorary member of the American Society of Mechanical Engineers, in the auditorium of the Engineering Societies Building, New York City. During the evening, under the auspices of the Gas Power Section, Dr. Diesel delivered an illustrated lecture on "The Development of the Diesel Engine."



DR. RUDOLPH DIESEL

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Dr. Diesel, it will be recalled, recently came to this country to investigate the progress which is being made here with oil fuel and on business connected with the Busch-Sulzer Bros. Diesel Engine Co., St. Louis, Mo., of which he is a director. The doctor has expressed himself as of the belief that America is destined to lead the world in the development of oil-fuel motive power.

Our issue of May 7 will contain a full account of his paper.

Lexington, Ky., is to have a stationary engineers' association. It will represent the engineers of central Kentucky, including those in Lexington, Georgetown, Paris, Nicholasville and Versailles. The first meeting, in which plans were discussed, was held in Lexington on Apr. 9. Officers will be elected shortly.

## Marine Engineering Publications Consolidated

The Aldrich Publishing Co., with a capital stock of $100,000, all paid in, has been organized under New York laws to take over under one management the engineering publications of Herbert L. Aldrich, which have hitherto been separate organizations.

These include *International Marine Engineering*, which he founded 15 years ago in the interests of shipbuilding, also a publication of the same name which he established in London, England, in 1906. Another publication is *The Boiler Maker*, covering the design and construction of steam boilers for locomotives, steamships and all other uses. Besides these magazines Mr. Aldrich publishes several tech-

nical books devoted to engineering subjects of interest in the industries covered by the magazines.

The head offices of the new company will continue as heretofore in the Whitehall Building, 17 Battery Place, New York City.

## OBITUARY

### Benjamin Guggenheim

The first definite information received of the death of Benjamin Guggenheim, whose life was lost in the going down of the ill-fated "Titanic" on Apr. 14, was received by his widow in a message from Mr. Guggenheim, delivered by an assistant steward who was with him until a few minutes before the "Titanic" sank. The message was: "If anything should happen to me, tell my wife in New York that I've done my best in doing my duty." In these words lies the keynote of Benjamin Guggenheim's whole life.

Born on Oct. 26, 1865, the fifth of the seven sons of Meyer Guggenheim, the founder of the great firm having mining interests all over the world, young Benjamin, at 20, took charge of the company's mining properties in Leadville, Colo., and to his shrewdness and energy is largely due the concern's success in after years. Later, he came East and managed a plant at Perth Amboy, N. J.

In 1903, Mr. Guggenheim erected a large machinery plant in Milwaukee, Wis., which was later merged in the International Steam Pump Co., of which he was elected president in 1909. With his brothers, he was also the controlling factor in the American Smelting & Refining Co.

Today, the International Steam Pump Co.'s products are limited only by the confines of industry in this country and abroad. It has seven plants, each large in itself, which operate in the United States, and one in England, at Simpson. The company employs 10,000 men.

Mr. Guggenheim married Miss Floretta Seligman, a daughter of James Seligman, the banker, who survives him with three daughters.

Benjamin Guggenheim

Copyright, 1912, Marceau, N. Y.

## PERSONAL

James O. Westberg, formerly chief engineer of the isolated plant at Feltman's, Coney Island, has accepted a position as erecting engineer with the Shipley Construction & Supply Co., the New York representative of the York Manufacturing Co., York, Penn., builders of ice-making and refrigerating machinery. Mr. Westberg is a member of the Modern Science Club, the N. A. S. E., and was the founder and first president of the Combined Engineers, Brooklyn, N. Y.

## Examinations for Inspection Service at Chicago

The Illinois Civil Service Commission announces that an examination will be held in Chicago on May 17 to fill present and future vacancies in the department of factory inspection in each of the following branches:

Electrical: Applicant must have practical knowledge of electrical generating apparatus and of the methods used in wiring and installation.

Ventilation: Must have both technical and practical training in ventilation and sanitation, understand the occupational disease law, and be able to locate and analyze industrial poisons.

Mechanical: Must be especially experienced in shop work and be able to detect infringements of laws governing the protection of workmen about machinery.

These positions pay $100 per month and all necessary traveling expenses; the age is limited between 25 and 50 years.

Copies of the laws may be had by writing to the State Factory Inspection Department, Security Building, Chicago. W. R. Robinson, of the Civil Service Commission, Springfield, Ill., will furnish application blanks. The aplication must be filed with the commission at Springfield prior to 9 a.m., May 10.

## Doubtful Economy

Hans Schmidt, proprietor of a western Minnesota sawmill, used for fuel the sawdust from the factory. It cost him nothing, but it kept four men busy shoveling it. Recently he was persuaded to put in a new equipment which would reduce the amount of fuel one-half.

After the machinery had been installed, the agent called, expecting to be congratulated. But the German eyed him gloomily.

"Doesn't the new plant do all I claimed?" he asked.

"Yah; but I oberlooks sometings," replied Hans.

"What was that?"

"Vell, it dakes only dwo mens to handle de fuel, but it dakes de udder dwo mens to haul away what we don't use und a team pesides."—*Hampton's Magazine.*

# Moments with the Ad. Editor

If good advertising is anything it is informative and helpful.

We have heard some people make caustic remarks about the quantity of advertising in a technical paper and we remember hearing a publisher of a trade paper wax hysterical over putting an advertisement on the front cover. He thought that the front cover should be devoid of advertising and would substitute a pretty picture for a well written and well displayed advertisement.

Any wise engineer can get more out of a good ad. than he can out of the best painting the world ever saw—and the average front cover "picture" is far from that.

Here, in any event, is what E. S. Wylde, of Pinerolo, Italy, thinks about ads. and especially the value of POWER'S advertising to its foreign readers:

There are just one or two things I should like to mention and which I thought might interest readers of POWER. On page 416 of your issue of March 19th you say: POWER never makes much of a "holler" about its foreign circulation, but it's "there," etc. Well, I don't know about the "holler," but I do know about its being there, all the same, so I thought perhaps a little personal experience might show some of your readers what those on the outskirts, as it were, of your circulation think about and how they make use of "Moments With the Ad. Editor" and the Ad. section of POWER.

I started to take POWER some four or five years ago when stationed in Mexico, and from the very first it both interested and instructed me, but it was only when I came here some three years ago and found myself up against some tough propositions that I decided to test for myself some of the many ads. that seemed to fit my case. Well, firstly the system of lubrication in the mill was both wasteful and inefficient under the old system of oiling, so I decided to try what Albany Grease would do, and I am pleased to say that it turned out A-1. and now we have no more oil dropping about and no trouble with hot bearings, and one man looks after all the mill in place of three employed formerly. Then again we had trouble with the separator on one of our engines of 200 hp. on account of the face of the bottom flange having several blow holes in it, which made it very difficult indeed to keep a tight joint, so I decided to see what "Smooth-On Cement" would do. I obtained a tin and after having had the joint carefully cleaned I applied the cement according to instructions and found I had a tight joint and I have not had to have it touched since, and that is eighteen months ago. Thirdly, we have several belt drives in the mill which are subjected to very severe service. They are fast-running belts with very short centers and small arcs of contact, which caused them to slip a good deal, particularly on Monday mornings, after the machinery had become cold and stiff by standing over Sunday. So I wrote for a can of "Cling Surface" and again the ad. made good and we have had no further trouble with those belts, and that is over a year ago. When one considers what a very heavy freight charge we have here I think it may be fairly said that POWER ads. "make good." And lastly it was in the Ad. section of POWER that I first saw about the International Correspondence Schools and convinced myself that it was a good thing, so I joined the Steam Electric course and have and am deriving both pleasure and profit out of it, and have been able to give our engineer some tips that have proved to be to our mutual benefit. It has also enabled me to appreciate more fully the various articles appearing in POWER.

So you see, Mr. Editor, even if it is not making a great deal of noise about it, POWER is doing a good work, and its ads. are making good in perhaps very many places outside the United States. I rather think if you were to invite some letters from these friends of yours abroad you would find them mighty interesting reading if nothing else.

Wishing you and your paper every success.

When the Selling Section brings real help to a man located far from the source of supply, it has proved itself worth while.

By the same token, those of its readers who are close to "headquarters," to whom freight charges are no handicap, can well profit by reading the ads. and buying advertised goods.

# NEW EQUIPMENT

### ATLANTIC COAST STATES

The French & Heald Co., Milford, N. H., will construct a power house in connection with its establishment, to replace the one recently destroyed by fire.

The Mount Holyoke Tissue Mills, Holyoke, Mass., will construct a power plant in connection with its establishment.

The Pawtucket Power & Electric Co., Pawtucket, R. I., will construct a new power plant.

Plans are being prepared by Griggs & Hunt, architects, for the installation of a power plant and steam-heating plant in the new addition to be erected for the Oakville Co., on Main St., Oakville, Conn.

Two 150-hp. boilers, an electric and a gas generator will be required at the plant of the Birdseye-Somers Co. to be built at Barnum Ave., Grant and Summerfield Sts., Bridgeport, Conn., for which J. E. Nitchie, 150 Nassau St., New York, is preparing plans.

Freney & Jackson, 51 Leavenworth St., Waterbury, Conn., are preparing plans from which estimates will soon be received for a new direct and indirect steam-heating system in the Clay St. School, Waterbury, Conn. It is estimated that the new system will cost $10,000.

The citizens of Stratford, Conn., have decided to change the street-lighting system from gas to electricity.

Frank Porter, engineer for Fort Pitt Hotel, Pittsburg, Penn., is taking estimates for equipment of the power plant to be constructed in the hotel.

A power plant will be constructed on Washington Ave., Philadelphia, Penn., for John Wanamaker.

The Baltimore & Ohio R.R. Co. will construct an electrical substation at the Mount Clare yards, Baltimore, Md. Estimated cost, $35,000. J. E. Davis is electrical engineer.

Greenboro, Md., will install a water-works system. Plans are being prepared.

### SOUTHERN STATES

The city council of Helena, Ga., has decided to install an electric-light system.

The board of water commissioners, Macon, Ga., will install electrical equipment to operate the new pumping station. W. P. Bullock, Kansas City, Mo., is consulting engineer.

Manchester, Ga., will receive bids until May 1, for the installation of an electric-light plant. James S. Peters is city clerk.

McRae, Ga., will soon vote on the proposition to install an electric-light system. Estimated cost, $5000.

La Grange, Ga., contemplates the expenditure of $150,000 for the installation of a water-works system.

The installation of an electric-light plant at Haleysville, Ala., is under consideration. An expenditure of $10,000 will be made. M. S. Drewery is city clerk.

Sumner, Miss., contemplates the expenditure of $20,000 for the construction of a water-works system and the installation of an electric-light plant. T. I. Rice is town clerk.

Crystal Springs, Miss., has voted bonds for $10,000, for improving the water-works system and electric-light plant.

Kentwood, La., will receive bids until May 3 for installing machinery in a pumping plant.

Bids will be received by F. S. Shields, secretary of the sewerage and water board, New Orleans, La., until June 20, for the construction of a power plant.

The Barbourville Electric Light, Heat & Power Co., Barbourville, Ky., will improve the street-lighting system. A. Smith is manager.

The Climax Roller Mills Co., Shelbyville, Ky., contemplates the installation of a 75-hp. engine.

### CENTRAL STATES

The Union Gas & Electric Co. contemplates the construction of a substation at Myrtle Ave. and Preston St., Walnut Hills, Cincinnati, Ohio. Estimated cost, $18,000. E. W. McClintock is chief engineer.

Mount Cory, Ohio, has voted a bond issue of $12,000 for the construction of an electric-light plant.

The city of La Crosse, Wis., has retained John W. Alvord, Chicago, Ill., to prepare plans for a new water-works system.

The Aluminum Castings Co. is contemplating the construction of a power plant in connection with its establishment, at Manitowoc.

The Beardstown Electric Light & Power Co. contemplates extensive improvements to its plant at Beardstown, Ill.

F. E. Wright has been granted a franchise to construct and operate an electric-light plant at Mahomet, Ill.

F. H. Mullen, J. A. Glenn, Louis Kief, James Snyder and William Walters are interested in the installation of an electric-light plant at Middletown, Ill.

J. T. Galloway, Greenfield, Ill., contemplates the construction of an electric-light system in Roodhouse, Ill.

The power house of the Illinois Steel Co., South Chicago, Ill., was destroyed by an explosion. The loss is estimated at $100,000.

### WEST OF THE MISSISSIPPI

The citizens of Anthon, Iowa, will soon vote on the proposition to construct an electric-light plant.

F. S. Smith is interested in the installation of an electric-light plant at Murray, Iowa.

Pierson, Iowa, has voted bonds of $4500 for the installation of a municipal electric-light plant.

P. J. V. Cross will install an electric-light plant at Quasqueton, Iowa.

The Home Lighting Co. has been incorporated to build an electric-light plant at Red Oak, Iowa. T. D. Murphy and H. E. Deemer are interested.

Ely, Minn., contemplates the installation of a filtration plant in connection with the water-works system.

The installation of an electric-light system at Everest, Kan., is under consideration. Estimated cost, $7000.

Bids will be received by Earl C. Rickel, city clerk, Edgar, Neb., about July 1, for the construction of a power plant on the Blue River.

Bowdle, N. D., is considering plans for the construction of a water-works system.

D. F. Smith, Great Falls, Mont., has been granted a franchise to construct and operate an electric-light system at Lewistown, Mont.

Roundup, Mont., will install a heating plant in the local school. L. Earl Brown is a member of the board of trustees.

Preliminary plans for the installation of a water-works system at Pleasant Hill, Mo., have been prepared.

The St. Joseph Ry., Light, Heat & Power Co., St. Joseph, Mo., will install a 3000-kw. generator in its plant. J. H. Van Brunt is general manager.

The Brinkley Light & Water Co., Brinkley, Ark., has retained R. C. Huston, Memphis, Tenn., to prepare plans for improving its plant.

The Delta Electric Light, Power & Mfg. Co., Greenville, Miss., will construct an electric-light plant at Lake Village, Ark. E. J. Lenz, Greenville, Miss., is superintendent and chief electrician.

Frankston, Tex., is considering the construction of an electric-light plant.

Plans have been prepared for the construction of a water-works system at Sherman, Tex. Harvey McDuffie is superintendent of water-works.

Terrell, Tex., has voted bonds for $25,000 for the improvement of its water-works system.

Durant, Okla., has voted a bond issue of $5000 for improvements to the electric-light plant.

Bonds for $35,000 have been voted for improving the water-works system at Brigham, Utah.

Paris, Idaho, has voted bonds for $14,000 for the construction of a water-works system. W. S. Hoge is city clerk.

The Idaho Consolidated Power Co. contemplates the installation of new equipment in its plant at Pocatello, Idaho. J. H. Brady, Boise, Idaho, is president.

F. J. Anderson will install an electric-light plant near Sultan, Wash.

Oceanside, Calif., will soon vote on the proposition to issue bonds for $25,000 for the construction of a municipal electric-light plant.

The Windsor Brass Mfg. Co., Windsor, Ont., will install a power plant in connection with its establishment. W. D. Murray is manager.

The Watrous Electric Light, Power & Traction Co. contemplates installing new equipment in its plant at Watrous, Sask.

# NEW CATALOGS

Mound Tool Co., St. Louis, Mo. Catalog. Tools for the engineer. Illustrated, 24 pages, 3¼x6 in.

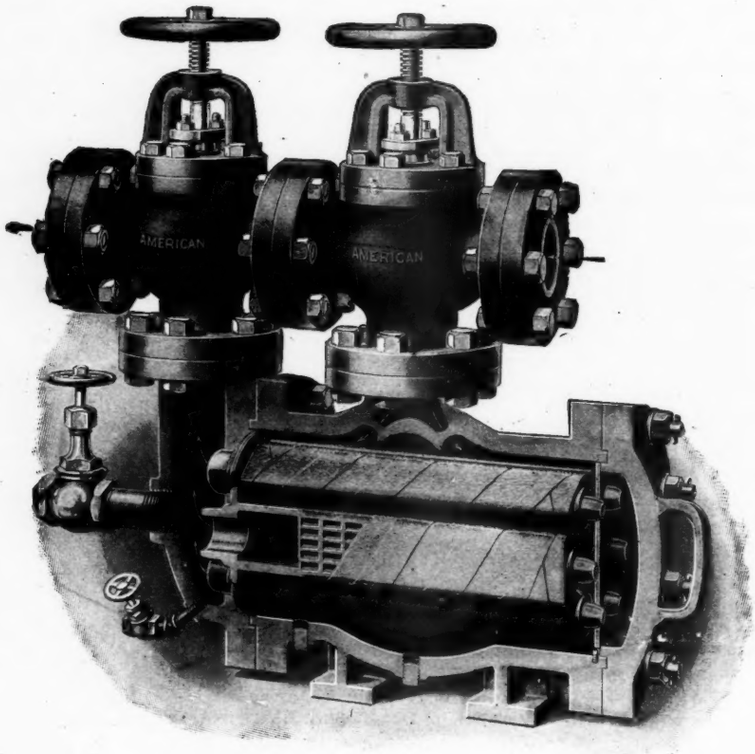
Falls Machine Co., Sheboygan Falls, Wis. Circular automatic engine stop. Illustrated, 4¾x7½ in.

V. D. Anderson Co., Cleveland, Ohio. Pamphlet. Engine-room oil filter. Illustrated, 8 pages, 3½x6 in.

Terry Steam Turbine Co., Hartford, Conn. Booklet. Terry service. Illustrated, 12 pages, 3½x6 in.

Industrial Instrument Co., Foxboro, Mass. Bulletin No. 61. Portable or hand tachometers. Illustrated, 8 pages, 8x11 in.

# Beware Of Oil And Grease Getting Into Your Boiler




Oil or grease is a serious menace. The instant oil or grease gets into the boiler, regardless of the pressure under which the boiler is working, you are taking a big risk and inviting serious trouble—to say nothing of possible loss of life and destruction of property.

The simplest remedy and a positive insurance against danger from grease or oil is the American $H_2O$ Grease Extracting Feed Water Filter. With this device your plant is protected. It removes every last particle of grease or oil from the condensation before it gets into the boiler and consequently eliminates danger of bagging plates—danger signals which are the signs of serious trouble.

Write today for the Pocket Edition of the American Catalog. Fill out and mail the coupon, it brings you this handy book without cost or obligation.

SIGN AND MAIL COUPON

American Steam Gauge & Valve Mfg. Co.
Boston, Mass. 4-30-12

. Send me your Pocket Edition catalog

Name. . . . . .

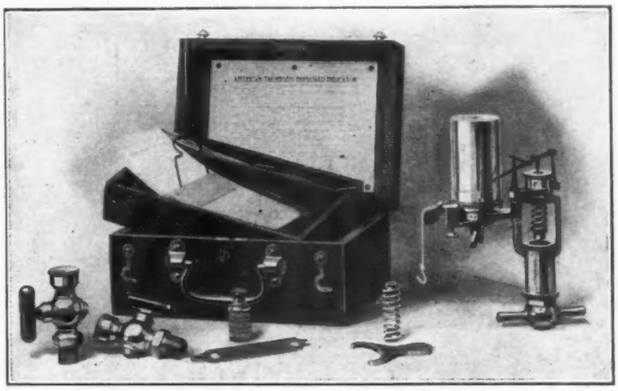
Address. . . . . .

**American Steam Gauge & Valve Mfg. Co.**
**Boston, Mass**

Sales Offices in New York, Chicago, San Francisco, Pittsburg, Atlanta, Montreal

THE BEST HOUSES EVERYWHERE SELL OUR PRODUCTS

# Know Your Engine And Become More Valuable



**The American-Thompson is the original Thompson Indicator. It is the most imitated instrument on the market. To be absolutely sure of getting the right indicator, ask for the "American-Thompson Indicator made by the American Steam Gauge and Valve Mfg. Co." Always specify it in that way.**

The American-Thompson Indicater will help you get better results from your engines, help you make coal savings, help you make yourself a better engineer, worth more money to your employer.

This instrument is not a luxury—it is a necessary part of the outfit of every engineer who is ambitions to get ahead.

We've made the terms of payment extremely easy so that you can enjoy all the benefits of using your instrument while you are paying for it.

**$5.00 Down $5.00 Monthly**

The price of the outfit as shown is $55.00, with reducing wheel $65.00. The cost of the detent motion is $15.00. The terms are easy—made easy to put this standard instrument within your immediate reach—$5.00 down and $5.00 per month.

Send $5.00 and two good references today; we will ship outfit at once and it's yours for examination for 5 days. Don't put this matter off any longer—take this opportunity now—you'll be the gainer.

## American Steam Gauge & Valve Mfg. Co.

**Boston, Mass.**

Sales Offices in New York, Chicago, San Francisco, Pittsburg, Atlanta, Montreal

THE BEST HOUSES EVERYWHERE SELL OUR PRODUCTS

SIGN AND MAIL COUPON

American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

Send me full details of offer No. 159

Name . . . . . .

Address . . . . . .

Schade Valve Manufacturing Co., 2528 North American St., Philadelphia, Penn. Catalog No. 3. Valves. Illustrated, 26 pages, 5x7 in.

R. H. Beaumont Co., Drexel Building, Philadelphia, Penn. Catalog No. 20. Coal and ashes handling equipment for boiler houses. Illustrated, 48 pages, 6x9 in.

## ENGINEERS WANTED

**Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.**

## HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

SALESMAN — Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesman Address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

AGENTS WANTED to sell forced draft blowers and damper regulators; will give exclusive territory to right parties; commission on sales. Turbo-Blower Co., 30 Church St., New York.

AGENTS selling to steam plants can make big money selling for us; no samples; no experience is necessary. Armstrong Mfg. Co., Springfield, Ohio.

SALESMEN who have established trade among boiler users; good salary, expenses and liberal bonus. Reiter Boiler Cleaner Co., Elgin, Ill.

ONE NIGHT ENGINEER by small electric light plant in northern Indiana; Corliss engine; must do own firing; wages $60; report May 1. Box 647, Power.

A MAN who understands the setting up and starting of high speed steam engines, both simple and compound; state experience and wages expected. Box 648, Power.

AN EXPERIENCED salesman of steam specialties for Central West territory; state age, experience, where obtained and salary expectations. The Ohio Brass Co., Mansfield, Ohio.

AGENTS WANTED—We want a live wire agent, either engineer or specialty salesman, in every town to furnish lists of names and take orders for Akron metal gaskets, the most complete line of metal gaskets made. Write for our proposition. Akron Metallic Gasket Co., Dept. P, Akron, Ohio.

MANUFACTURERS' AGENTS to handle thoroughly guaranteed steam specialties; feed water heaters, steam and oil separators, traps and exhaust pipe heads; not necessary to represent entire line if interested in only part of it; our specialties are well advertised and of good reputation. Box 569, Power.

## SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

ENGINEER desires to change position; best of reasons; steady and sober; four years in navy; long hours no objection. Box 644, Power.

SUPERINTENDENT or manager of factory, power plant or engineering business, by exceptionally experienced mechanical engineer; age 32; graduate Cornell. Box 651, Power.

CHIEF ENGINEER, 20 years' experience of successful operating and installing steam and electric power plants; familiar with central railway and lighting station, high tension and direct current equipment; first class Massachusetts license; 40 years of age and best of reference. Box 650, Power.

## MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

WANTED, complete 1910 volume "Power" in good condition. Box 630, Power.

PATENTS SECURED—C. L. Parker, Patents, 904 G St., Washington, D. C.

WANTED—A good second hand cross compound engine about 350 to 400 h.p.; also 60 h.p. simple Corliss; give full particulars. Box 645, Power.

WANTED—200 kw., 250 volt, direct current generator, direct connected to simple or compound engine. A. S. Halstead, 50 Church St., New York.

WANTED—A second hand 350 to 400 kw. direct connected unit, 250 volt d.c.; also about ten 220 d.c. motors from 20 to 50 hp., one with variable speed; describe in full. Box 646, Power.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. M. Y. C., 1417 W. Jackson Blvd., Chicago, Ill.

## FOR SALE

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

20x48 CORLISS engine, excellent condition, $650. Duzets & Son, Hudson Terminal, New York.

TWO RUST water tube boilers, 200 hp. each, 180 lb. working steam pressure; never had steam in them. Box 649, Power.

CHEAP—One 30-hp. Diesel oil engine with duplicate parts of a wrecked one. Seib Bros., 96-100 Boyd Ave., Jersey City, N. J.

350 KW. WESTINGHOUSE generator, 250 volts, direct connected to 24x36 heavy duty Corliss engine; unit complete with switchboard and balancing set. Arthur S. Partridge, 417 Pine St., St. Louis.

BARGAINS in second hand steam engines; 10x10 low pressure vertical New York Blower Co., 7x10x15 Atlas, 11½x16 throttling balanced valve, 10x12 Allfree, 12x12 Ideal, 15x14 Ideal, 10x20 Buckeye, 12x24 Buckeye, 17½x10x20 Buckeye. Power Equipment Co., Minneapolis, Minn.

ONE 120 kilowatt, a.c., 440 volts, Westinghouse generator, belted to 16x42 Allis Corliss engine, complete with exciter, switchboard and all fittings. One 20 kilowatt, d.c., 230 volt, C. & C. Electric Co. generator, direct connected to 8x10 Allfree engine. All of the above in fine shape. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

ONE 150 HP. BALL automatic 16x16-in. engine, direct connected to 100 kw., 115 volt, d.c. G. E. generator. $1550. One 28 hp. Harrisburg automatic 8½x8-in. engine, direct connected to 18 kw., 115 volt d.c. Westinghouse generator. $600. Three 72-in. by 18-ft., 150-hp. butt joint H. T. boilers for 125 lb. pressure, with H. D. D. furnaces and I-beam suspension. $600 each. All in fine condition, taken out to make room for larger units. The above prices are all f.o.b. Portsmouth, Ohio. The Selby Shoe Co.

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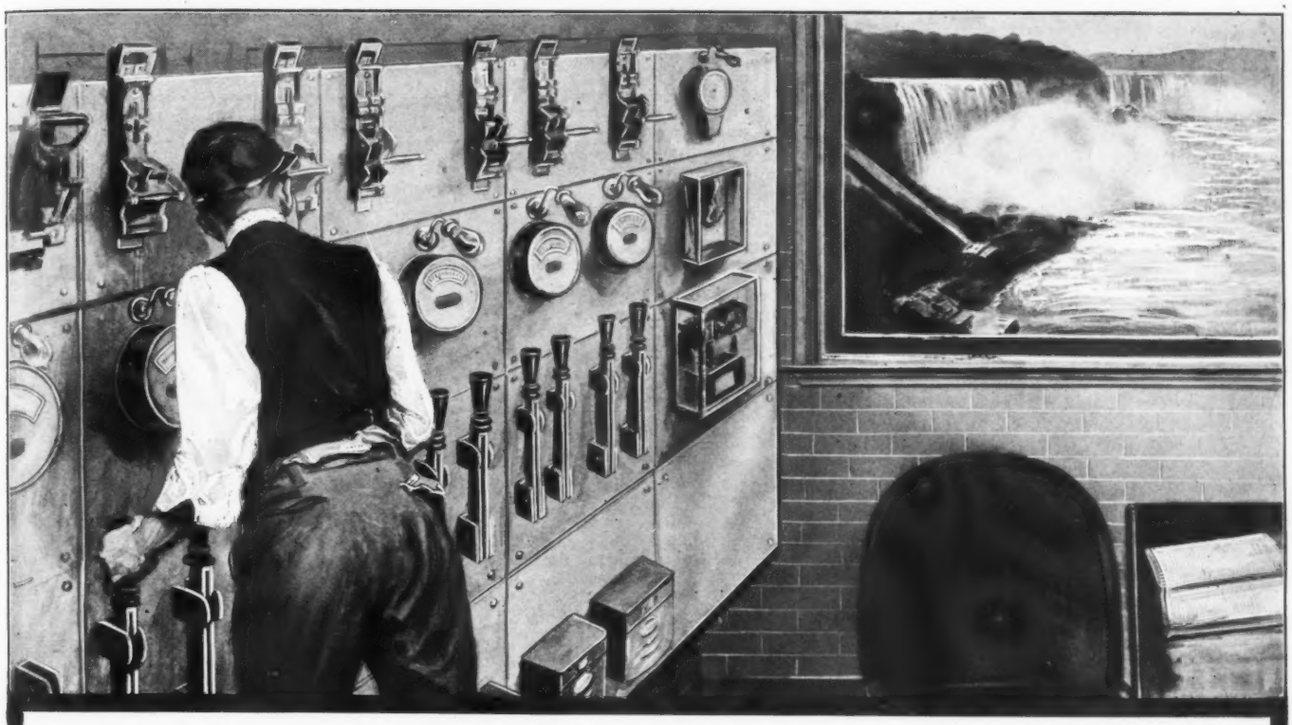

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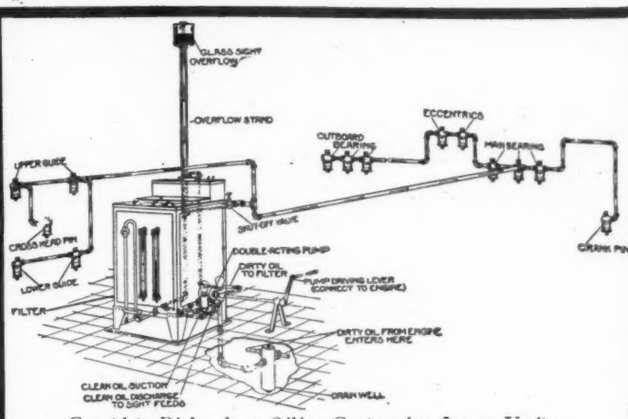


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# The Canady Combustion Controller

## "The Controller That Controls"

*How is it Used?*

It is used in connection with the Canady System of Undergrate Draft.

*What is its primary advantage?*

It's the first machine made that automatically controls either the air blast damper, or the flue damper successfully, according to furnace conditions.

*How do we know this?*

The U. S. Patent Office Records show that it's the original design, while numerous large installations have proven it successful.

*Is there an instance where it has not been a success?*

We know of none. Three years ago, the N.Y. Edison Co. installed 84 of them, and there has never been a complaint regarding their operation. The Bush Terminal Co. (Brooklyn) has them operating on 8000 boiler h.p. and indorse them highly. Three repeat orders of 7 machines each from the Metropolitan St. Ry. Co. show that they are pleased. Many other installations daily affirm their success.

*How does it operate?*

Very simple. The pressure in furnace (A) is communicated to swinging diaphragm (C) which action admits and discharges pressure to and from cylinder (G) automatically controlling air-supply damper (H).

*Suppose changes take place in the furnace due to the different thicknesses of fuel bed—What happens then?*

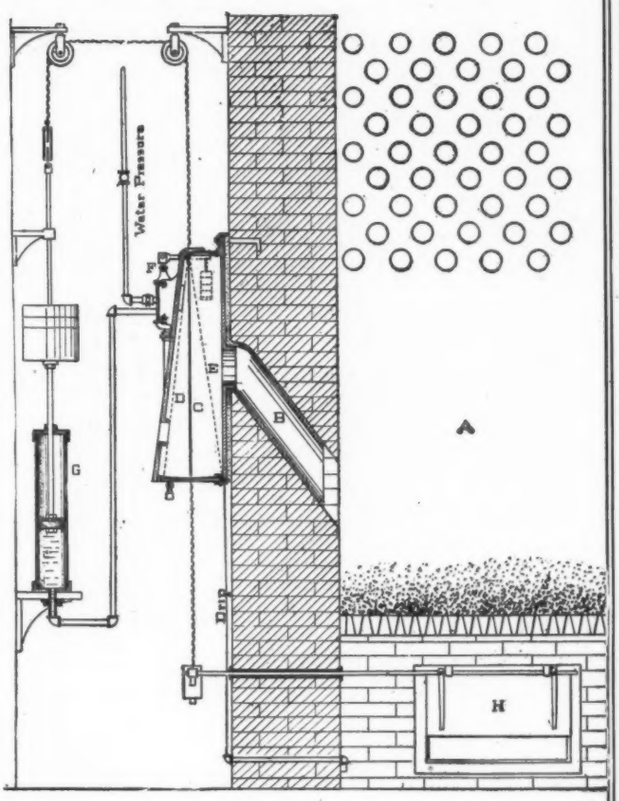
As the fuel bed becomes thicker, the furnace pressure will be reduced, causing the diaphragm (C) to swing inward, thus admitting sufficient air to the fire. The reverse is the case when the fuel bed is burned out or becomes thinner.

*Does Controller require much attention?*

No. It requires none. Its action is positive and entirely automatic.

*Has it a close regulation?*

Yes. It can be adjusted to maintain any desired draft in the furnace within 2-100 of an inch water gauge.




*Why has the Canady System been so successful?*

Because the desired result of mechanical draft equipment can not be obtained without proper regulation. The Canady Controller furnishes this regulation continuously.

It permits economical burning of all fuels. Maintains even furnace temperature. Prolongs the life of settings. Prevents any blow out of gases from fire doors. And has many other advantages that accomplish in a practical manner the end that every engineer has sought, but which no machine before has ever offered. That is, it automatically controls the air blast damper and the flue damper *successfully*, according to furnace conditions.

*The above describes briefly only a vital part of the Canady System—the Controller. The System complete consists of standard blowers, engines, regulators and the Canady Controllers. Systems installed complete or in part. Full particulars, Illustrated Booklets and Descriptive Matter sent on request. Write.*

## BLAISDELL-CANADY COMPANY

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